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SEEDLING CANES IN INDIA.

BY

C. A. BARBER, SC.D., F.L.S.,

Government Botanist, Madras.

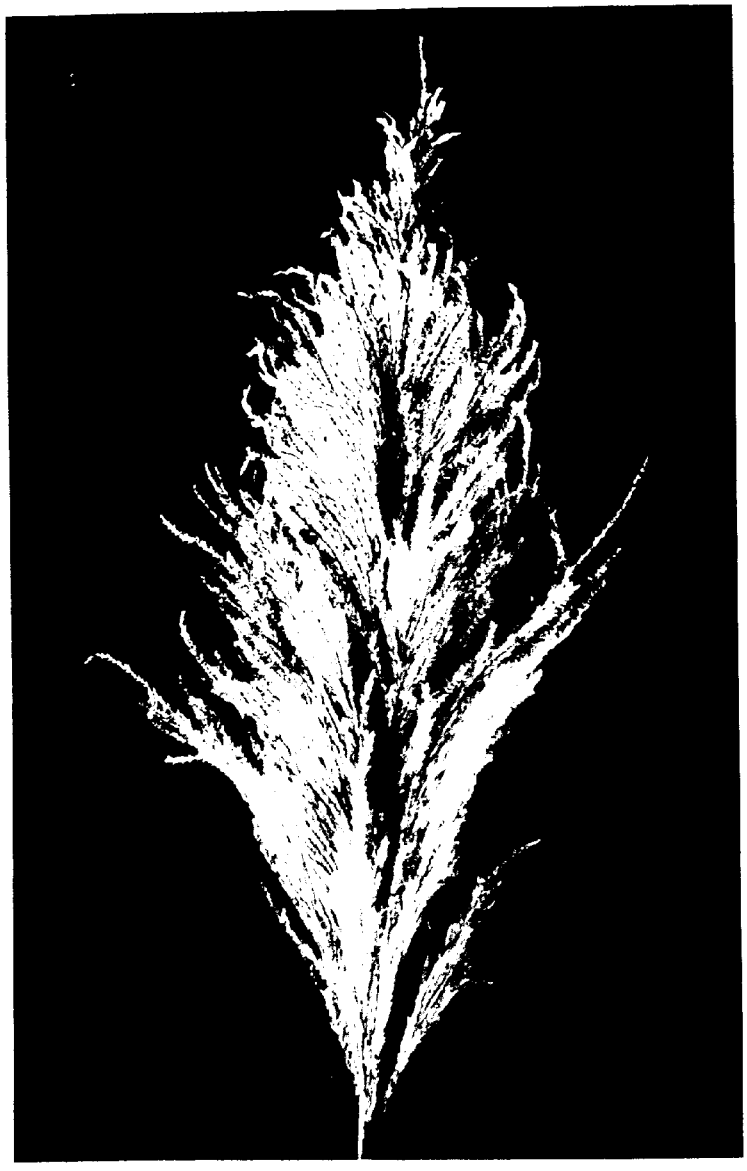
THE Sugarcane has, from time immemorial, been planted by cuttings, that is to say, by pieces cut from the parent plant and put into the ground. This mode of propagation, without the aid of fruit and seed, is called "vegetative." In the case of plants reproduced in this way we not infrequently find that the seed is more or less infertile, as if, from long disuse, there had been a gradual loss in germinating power: in extreme cases no seed is formed at all, as in the plantain and pineapple. It was not unreasonable therefore for those connected with the sugarcane industry to assume that seed was either not formed in this plant or, if formed, was infertile. This loss of seed is, however, by no means an unmixed evil. There is, in fact, a distinct advantage in purely vegetative reproduction. By this means, and by this alone, are the whole of the parental characters transmitted to the offspring. And this need cause no surprise, for propagation in such a manner simply prolongs the life of the individual indefinitely. A bud or branch of the parent plant is removed and, by suitable treatment, made to form roots and to grow on for a further period. There is no reason for a change of characters in plants whose life is thus prolonged.

NOTE. The main facts in this sketch were presented in a paper read before the Students' Association at their annual meeting at Coimbatore on July 13, 1912. It is only fair to state that, although similar work on stamens to that described has been done in other countries, I was unware of this when my observations were made. I also take this opportunity to record the great assistance which I have received throughout from my Assistant, M. E. Ry. I. S. Without it much work would have been impossible. I could not have done the work.

beyond the gradual adaptation of the organs and tissues to their climatic surroundings. Viewed from this standpoint, the sugar cane is one of the oldest plants living, having probably an uninterrupted life of at least 4,000 to 5,000 years. We know at once that if we plant pieces of a cane with rich juice we shall get this character in the resulting crop and, if we take a common, hardy, thin cane, we shall get the same characters repeated in the field. Hence has arisen the whole art of grafting, where plants have been found deficient in the power of forming fresh roots on detached branches but have shown that their tissues will readily unite with those of other similar plants which are already rooted. And we are thus sure of preserving the good qualities of the best kinds of apples, pears, mangoes, guavas and oranges.

In raising plants from seed or by "sexual" reproduction the position is reversed. Instead of one parent there are two, and this union of two parents has been observed to result in much variation in the offspring. This can be readily seen in a seed bed in any garden where, beyond a general resemblance, there are a great number of minute differences in the seedlings. And it would appear probable that this variation is even greater in plants usually raised by the vegetative method, for no pains have been taken to select such forms as are "true to seed." As examples may be mentioned the orange and the common garden "croton." The seedlings obtained in both these cases appear to be of the most diverse nature, many of them "reverting" to useless types. But in this variation lurks as great an advantage to plant-growers as that noted above in vegetative reproduction, for only by raising seedlings can we quickly obtain new varieties of plants, and by crossing two varieties we can obtain many intermediate stages. We can thus obtain hybrids uniting the characters of the parents in different degrees and, by taking sufficient care, we may even succeed in building up new varieties having the good qualities of several kinds. By crossing a tree producing fruit of exquisite flavour but of delicate growth with a strong-growing variety with poor fruit we may succeed in obtaining a strong-growing tree with

PLATE XLI.



A. J. I. SUGARCANE ARROW. POOVAN, COIMBATORE.

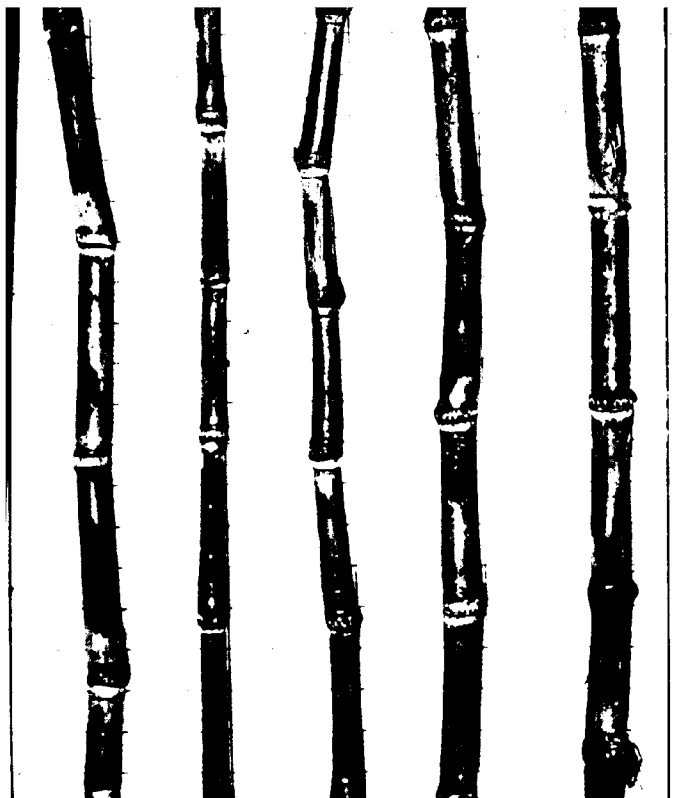
good fruit, and so on. Experience has shown that there are only certain characters which can thus, so to speak, be split up and transferred. Such characters as the colour of a flower, the shape and markings of a seed and the divisions in a leaf are comparatively simple and may easily be transferred. Far otherwise are the important agricultural characters of fruitfulness, sturdiness, adaptability and comparative resistance to disease, many of them being highly complex and depending on a number of conditions. The last named is perhaps the most important in the crops of the day, in that the intensive cultivation to which they are subjected seems to have greatly increased the number of pests to which they are liable. It is one of the most interesting advances of recent years that this character of liability to disease has in certain cases been determined to be a heritable character and one which can be transferred from one plant to another by suitable crossing. It is true that this has hitherto been done usually with regard to only one specific kind of disease in each case, but the fact is none the less important on that account. Thus Biffen has demonstrated that immunity from rust in wheats can be transferred from one race to another. He has been able to implant the rust resistance of poor, hardy forms upon varieties with excellent flour-forming character but heavily attacked by rust.

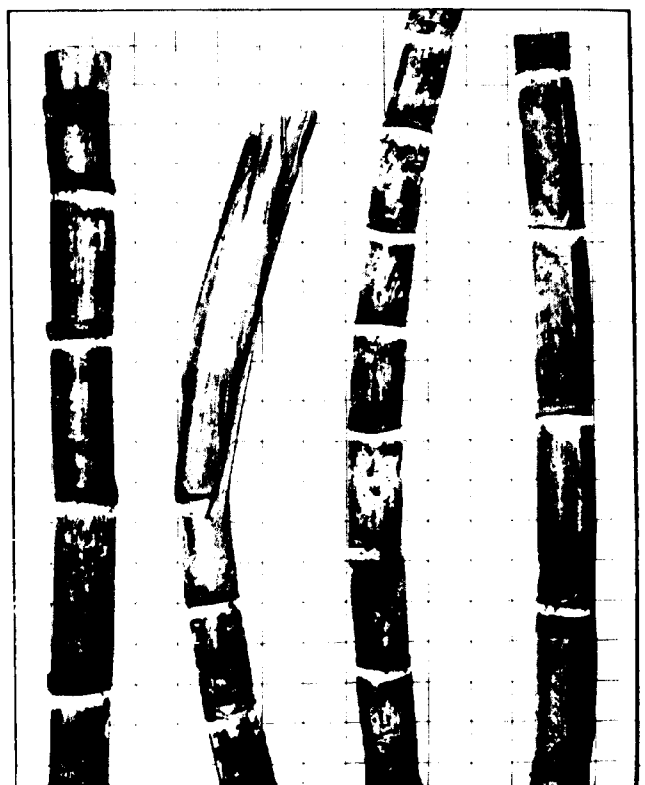
In view of these facts, the raising of canes from seed becomes a matter of great importance to the industry. The fertility of cane seed was first demonstrated in Java in 1887 and, independently, in Barbados in the following year. And the question at once arose as to whether, in the sugarcane as in other plants, new varieties might not be raised from seed. At this time the industry was passing through a very severe crisis. The good old kinds which had made cane cultivation a very profitable concern were being subjected to a very heavy strain through increasingly intensive cultivation caused by the growing rivalry of beet sugar. Year by year the cultivation of beet was greater and the sugar content in the beet plant was being intensified by chemical selection among the seedlings, while the

canes in different parts of the world were becoming more and more diseased. Their constitution was apparently giving way under the strain put upon them and it soon began to be asked whether it would be possible to continue growing sugarcane as a paying crop or whether, as more recently in the case of indigo, this industry would have to be given up.

The chance of obtaining new varieties of sugarcane was therefore eagerly seized in all sugarcane-growing countries and the Agricultural Departments in Java, the West Indies, British Guiana, the United States and Mauritius, as well as many private planters in these countries, quickly raised a mass of seedlings. It was, however, soon discovered that the great bulk of these seedlings were of very inferior character if not entirely worthless, many apparently reverting to some ancient condition resembling what one might suppose to be the original wild form of the plant. Much of this earlier, unchecked labour was therefore lost, for few could devote the time necessary for the arduous task of selection. But, in a few places, this failure only led to redoubled efforts and acted as a stimulus, so that still larger numbers of seedlings were annually brought into being, while they were subjected to the most careful system of weeding out. To give some idea of the necessity and laboriousness of this selection one or two cases may be quoted. In five years, Barbados raised some 20,000 seedlings and it is recorded that less than 1% of them are likely to prove of ultimate value. In the same number of years, British Guiana produced 330,000 seedling canes. Of these some 26,000 were grown on for further study: 50 were finally sent out to the planters for testing on a field scale and it is surmised that, of the whole number, about a dozen may, in course of time, be added to the canes grown in the country.

Many interesting facts have come to light in this investigation, of which only two are mentioned here. Some of the seedlings were found to be much less attacked by disease than their parents and showed more or less immunity to the common fungus-pests. There was also noted a great increase in the fertility of

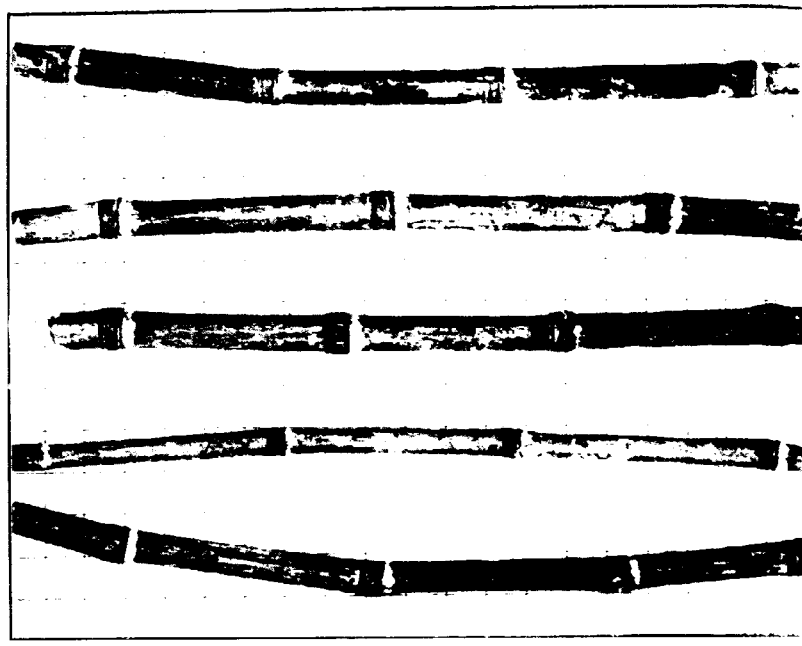


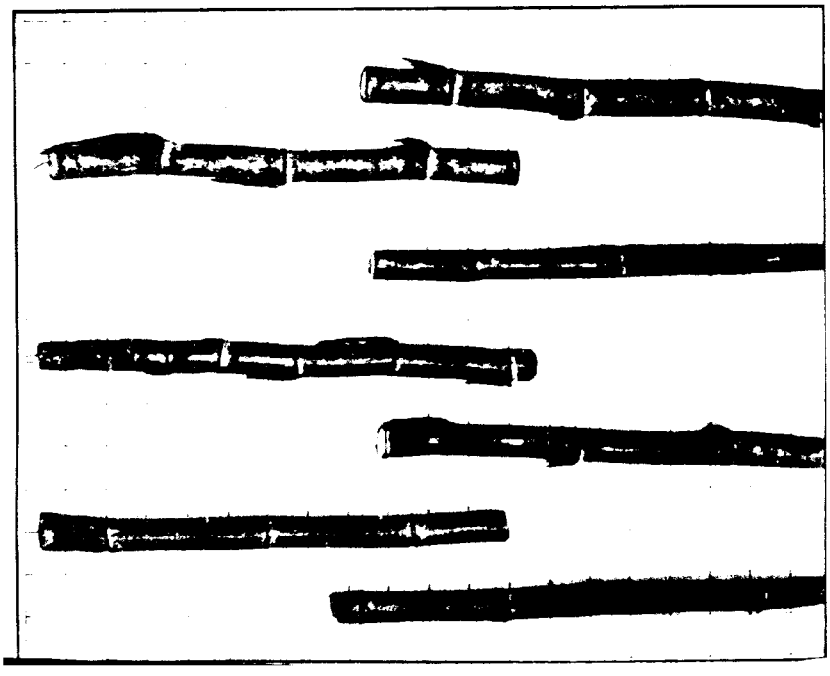


the cane flowers. While at first it was considered satisfactory to obtain 20—30 seedlings from an arrow, nearly 1,000 seedlings have now been raised by sowing a single arrow of a seedling cane. This is, after all, not unnatural. We may offer an explanation by assuming that the cane flowers had in course of time become infertile and imperfectly formed because of long neglect in selecting plants with fertile seed for propagation, in that the plant had been for ages propagated by a vegetative method. On the other hand, when seedlings were raised, it was from those few plants which retained their power of producing fully formed flowers and, by raising seedlings from such plants only, this character had become intensified.

A glance at the literature of the subject abundantly justifies this laborious work, and the cane industry has greatly profited by the experiments conducted in raising seedling canes. In place of the former despairing attitude, the growing of canes has received a new impetus and, in Java, the West Indies, Mauritius and the United States, the rivalry of beet sugar is no longer a matter of urgency. I have selected Java for a more careful consideration, because of an excellent summary which has recently come to my hands from the pen of Prinsen Geerligs, and from which the bulk of the following notes have been taken. In Java, before 1850, there was practically only one kind of cane grown, the White Cheribon. In that year an enterprising planter noted a red cane among the rest, separated it out and multiplied it until he could plant a small field with this variety alone. He found, on testing it, that it was more hardy than the White Cheribon and produced a larger tonnage of cane to the acre, and that the juice of the canes was richer. In many parts of the island this new cane rapidly replaced the older, white one. In 1882, however, a planter in the extreme west of Java noted that his canes were stunted, developed many aerial roots and multitudes of side branches which never grew beyond a few inches in length and of course formed no canes. This will remind many of the cane growers in South India of the curious bunching growth so frequently noticed when the

canes are irrigated with alkaline water or cropped for several seasons without change of seed. Around Coimbatore this form of growth is known as "shuleh kutteh," and in Java the disease became known as "sereh" from its resemblance to the common lemon grass which is called by that name. Each year this disease spread further eastwards until, in 1892, it had reached the extreme eastern point and entered the neighbouring island of Bali. Every field was attacked, excepting such as were in the hills. At first, while the eastern estates were still free from the disease, a constant stream of cane sets passed from them westwards, the planters hoping thus to stem the spread of the disease. Government gave rebates on all canes sent by rail and, in 1888-9, went so far as to carry them free of charge. The result was, however, as stated and all the fields in the plains were attacked in turn. Two main facts had, however, been noted regarding the disease. Firstly, that ratoons were much worse affected than plant canes and, secondly, that the fields in the hills were comparatively free from disease. Sets introduced from such fields could be grown for one or two seasons before becoming affected. Ratoons were accordingly given up altogether and each plantation made arrangements for obtaining its seed canes from the hills. It was estimated that in one year alone some £200,000 were lost to the island through the disease, and these losses made it difficult for the planters to meet the extra heavy expenditure on hill plantations, at the very time, moreover, when the beetroot was challenging the supremacy of the sugarcane as a sugar producer. During this period several fully-equipped scientific sugar stations were founded to study the plant in all its aspects, but with special reference to the diseases to which it was subject. Failing to find a solution of the sereh difficulty, they turned their attention to the importation of canes from various other countries. And it is interesting to note that among those introduced was one called "Chunnee" from India, about which more will be said later. A number of these introduced varieties proved to be less subject to the disease than the local canes and thus the industry struggled on, but none





were considered completely satisfactory or could replace the canes hitherto grown with such success.

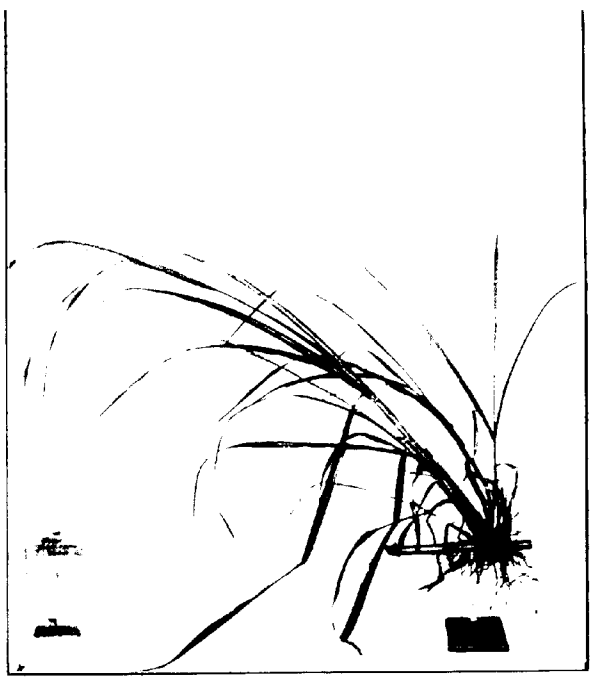
With the discovery of the fertility of cane seed a new phase in the contest was entered upon. The energies of the scientific officers at the stations were largely diverted in this new direction and multitudes of seedling canes were produced, a work which is still going on, the Indian Chunnee being largely used as a parent. The result of this work is described as eminently satisfactory. Many places now exist in Java where the seedlings have completely ousted the old canes. Some of these seedlings ripen early and some late; some can resist drought while others are at home in waterlogged conditions. There is in fact so great a selection of varieties that every planter may not only plant up each of his fields with the kind best suited to it but may, by careful arrangement, have a continuous supply of fresh canes for his mill throughout the whole of the milling season. This last factor is one of the utmost importance for the economical working of the factory, and it may safely be stated that the Java industry is in a very much better position than it ever was before. And this is borne out by the fact that the output has risen from 600,000 tons, before the appearance of sereh, to 1,230,000 tons last year, placing Java second only to Cuba among the exporting countries in the world.

It is perhaps hardly necessary to emphasise the fact that the cane industry in India is in a very unsatisfactory condition. Although probably the greatest producer in the world, most of the better-class canes are heavily diseased and in some parts of the country have, because of this, given way before inferior but more hardy varieties. The canes themselves are of a very poor class, for, while those in Madras may compare with the canes of other countries, they are grown on a very small scale, and the varieties in the great sugarcane areas of the north of India are among the poorest in the world. It is not therefore a piece of idle scientific curiosity to attempt to raise seedling canes for India. The invasion of the markets by beet sugar has indeed reached such a stage that little short of a revolution in cane-growing is needed

if the industry is to be continued. Efforts at raising cane seedlings in India have been made at various times and places in a desultory manner. Perhaps, the best results hitherto obtained were those of Samalkota sugar station some years ago. About 100 boxes of sterilised earth were sown with cane arrows, a special shed being built for their reception. Two seedlings were ultimately produced but both died in early infancy. There was not at that time the opportunity to continue the experiment or to make a study of the causes of this failure, but the general conclusion arrived at was that the dry air of continental India was fatal to the preservation of the seed, with its known ephemeral character, if it was not destructive to the essential reproductive organs of the flowers themselves. The work of the station was confined, as in Java, to the introduction of canes from other countries, in the hope that, by this haphazard method, some might be found to replace the dying canes of the Madras Presidency, then suffering from a disastrous fungus disease. The results were unexpectedly and perhaps undeservedly successful and Madras may now claim to have as fine a set of canes as any part of India. The method is tedious and costly and subject to much disappointment. Of those brought in, it was quickly seen that none were really immune, and there is a probability that ultimately all will succumb in turn when placed under the adverse conditions of the local agriculture. It may be noted here further that hardly any of these canes are suitable for introduction into the large areas under cane in Northern India.

When at the last meeting of the Board of Agriculture the idea of a cane-breeding station was mooted, I must confess to having felt great doubt as to whether we could raise sufficient seedlings in India to make the work of selection a success, and the possibilities of acclimatisation appeared to me to be distinctly more promising. It occurred to me, however, that, if the whole question were studied at Coimbatore, we should have a much greater chance of learning the real cause of the difficulties hitherto experienced in raising seedlings. Besides the advantage of

A. J. L. Paddy of Coimbatore 80 days.



Cheena of Mysore 96 days.

well-fitted laboratories at the college of agriculture, it was remembered that the canes flower very freely every year in the fields of the neighbourhood.

Unfortunately when the work was commenced, most of the flowering season had passed, but in the Xmas holidays there were still some arrows left and these were submitted to a careful examination. Some 300 pots were sown with such as could be collected from surrounding villages. I do not here propose to enter into the long series of disappointments which encountered us from the very start. At first there appeared to be an almost instantaneous success, but almost all of the first seedlings turned out to be those of grasses, the seeds of which appear to have been blown on to the pots. But these apparent successes buoyed up our hopes and incited us to new endeavours, so that, before the season was over, we could be certain of at least a dozen healthy cane seedlings which, although excessively delicate at first and of very slow growth, have now been safely planted out in the Botanic Garden and are growing very strongly. Our studies as to the causes of infertility had meantime led to certain results. A careful examination of the arrows themselves to see if we could detect any attached seeds produced negative results and, after many trials, we isolated one doubtful specimen. The stigmas in the flowers appeared to be well formed and receptive. They readily took up the pollen of wild Saccharums, the pollen of which germinated and entered the tissues, and a few cases were noted of adhering pollen in the field. But the ovaries obstinately refused to swell when dusted with the anthers of all the arrows we could obtain. Meantime the anthers themselves had been carefully studied. Most of them were ill formed and, among the first few hundreds of arrows hardly any were found to be open. Most of them remained thin and wilted quickly and, when dissected, contained no perfectly formed pollen. Attempts to grow the pollen in nutrient solutions were uniformly unsuccessful. Arrows were now obtained from Taliparamba, Palur, Samalkota, Mysore and the United Provinces. Out of the whole series three were noted in which a fair number of anthers

were open and contained what appeared to be fully mature pollen. These were Red Mauritius from Taliparamba, Purple Mauritius from Palur and Cheni from Mysore. Efforts were made to obtain fresh specimens of these as they were not in flower at Coimbatore, but in only one case were any arrows left in the fields, those of Cheni in Mysore. Through the kindness of Dr. Coleman, a fresh set of arrows of this variety were obtained and every one of them at once sown. It was surmised that, as the anthers were open, the stigmas might have been pollinated and the ovaries fertilised. This surmise proved to be correct, and in a few days some fifty healthy seedlings were found in the pots. Most of these have been successfully reared and are being planted out.

I had for some time suspected that this infertility of the stamens was the true cause of our failure, and the same view had been expressed to me in letters from the United Provinces. It will be remembered that something of the same kind occurs in the pepper. There are many botanical points of resemblance between these widely separated members of the vegetable kingdom, and in the pepper it has been demonstrated that the only way in which to be certain as to the fruitfulness of a vine is to note the relative quantity of stamens present. In both the pepper and the sugarcane, the stamens remain attached for a long time to the inflorescence, even after all its parts are quite dead, and a single glance with the lens will show their character.

The following canes were noted as flowering during the past season:—Ashy Mauritius, Striped Mauritius, Red and Green Sports from the latter, Red Mauritius, Purple Mauritius, Fiji B and Fiji C, Barbados 1529, Java 36 and 247, Vellai, Namam, Poovan, Kandai Boothan, all from Madras: Cheni from Mysore and Chin, Desi Saretha and Dhaula Saretha from the United Provinces. Unfortunately I have not succeeded in keeping arrows of all these, especially such as flowered locally, not knowing in what direction our study would develope until too late to obtain any more arrows. The arrowing season appears to be over early in Coimbatore. But all of those which

PLATE XLV.

A. J. I. Ashy Mauritius, Coimbatore—82 days.

Rheora, Bengal—80 days.

PLATE XLVI.

A. F. L. DIFFERENCE IN HABIT OF THE SEEDLINGS OF SACCHARUM SPONTANEUM.

I had kept were carefully worked over to determine the percentages of open anthers in each kind. The results are interesting, although, from the nature of the case, they can in no sense be considered as final. The arrows have not in any way been selected, and we do not at present know what contributary causes there may be to assist in the formation and opening of the stamens. In each variety examined about 200 anthers were sorted under the lens, a tedious piece of work, as they are extremely small and many of them had to be turned over with the needle.

(1) No anthers were found open in Java 36, Java 247, Chin, Desi Saretha and Dhaula Saretha.

(2) From 0·5 to 4 were seen open in Striped Mauritius, Red and Green Sports from it, Barbados 1529, Fiji B and Vellai.

(3) From 30 70% of open anthers were found in Red Mauritius, Cheni and Purple Mauritius.

From these numbers it would appear that, while certain of the canes examined produce a very fair number of fertile stamens, only one of these is a native of the country, the Cheni of Mysore. And the question naturally arises as to whether this is the "Chunnee" noted as having been imported into Java from India. It is celebrated in that country as having an abundance of healthy pollen, and is extensively used as a father in the crossing experiments for raising seedlings. J 36 is one of its descendants and appears in many respects to be a useful cane for introduction into Northern India.

This simple observation not only solves our great difficulty in raising seedlings, but even places us at an advantage with regard to other countries, where more canes produce good pollen. We can, for instance, more readily obtain a desired cross with known parentage, in that there is little chance of our local canes being self-fertilised. Both the Cheni and the Red Mauritius are, in addition, excellent canes in their way, more or less hardy, and to a certain extent, immune from the local diseases. We can thus look forward with some confidence to a time when the work of

producing seedling canes in India will be circumscribed less by the difficulty of obtaining them than by the lack of means for dealing with them properly when thus raised. The work is now rendered possible, but it is none the less arduous. The main labour will always be the selection of the seedlings when raised, keeping such as are likely to be of interest and rejecting those that are obviously worthless, and submitting the former to a continued scrutiny for several years before finally putting them out for growth in the fields. Even if we are content with a modest 1,000 seedlings each year, there will, in a few years' time, be a very large number under observation.

In order to save time and labour in this selecting work, every effort is being made to obtain criteria which can be used in early life for the retention or rejection of the seedlings. As was to be expected, seedlings even with the same parentage vary very much and each is subjected to a careful analysis and photographed before planting out. But for this study to be of any value, it must include that of all the varieties of canes which we can lay hold of. At present only about 90 varieties have been collected, as the work was started too late in the season for making a more complete collection. The shoots of these are photographed at about 80 days' growth and any marked characters noted. But here again it is very difficult to know what characters in the shoots are of systematic importance, and it will be only after a detailed study of a large number that we shall learn whether this laborious investigation will repay the trouble taken. At the time of writing, the work is hampered by other duties, and such observations as have been made are not in a fit state for publication. When the seedlings begin to form canes the interest will of course increase. Many of them will, at the first glance, be found to be too thin for propagation with advantage and many will be subject to disease. But it is probable that for some time to come all the seedlings raised will have to be kept to obtain data for a general basis of classification. Agricultural classifications are very different from those of wild plants, in that they are often dependent on minute differences in the part of the

A. J. I.

DIFFERENCE IN HABIT OF CHENI SEEDLINGS—ALL OF THE SAME AGE.

(The scale is divided into half foot divisions.

PLATE XLVIII.

1

2

3

4

A. J. L.

THE OPENING OF SUGAR-CANE ANTHERS.

1. Cleni.
2. Saccharum Spontaneum.
3. Vellu.
4. Red Mauritius.

Magnified 10 times.

plant for which it is cultivated or, indeed, on differences which altogether elude the botanist and which are mainly agricultural in nature. The classification of canes has been attempted many times, but the best of them depend on the character of the grown canes, and here the main divisions are based on the colour of the rind. This is at once seen to be an unsound basis in that a striped cane, sporting as it often does into red and green varieties, at once belongs to the three main divisions, red, yellow and striped, although all the time it is one cane divided up into its several parts. The mature canes thus far collected have been subjected, as they arrived, to a very special study, all of them having been drawn and photographed to scale. The latter is especially important because it is quite likely that the canes grown under new conditions will soon change in their thickness and general character. It is only by constantly growing them under the same conditions that we shall be able to determine their relationships. A fair number of differences have been already noted, and it is hoped that the way is being prepared for a scientific classification of the canes of India, one of the first and most important items of work in a cane-breeding station. A certain number of useful observations have already been made which tend to simplification. For instance, the Karunananthapuram cane received from Tanjore appears to be identical with the Kandai Boothan of Coimbatore, and both appear to be green sports from the Striped Singapore, a cane widely distributed over South India under various names. This result rested largely on the discovery of a "Chittan" cane in Coimbatore fields, which had the striped character in its lower half and the green in its upper. In the same way it seems probable that the Hospet cane, which succeeds so admirably in the Bellary district, is identical with the heavily diseased Keli of Godavery and the Poovan of Coimbatore, and lastly with the Pundia of Bombay. It is a curious fact that this cane varies greatly in the richness of its juice and its liability to disease in the different regions where it is to be found. For such generalisations and simplifications a very large series of canes collected

from all parts is necessary, and it is unwise to attempt much in this direction until a far greater number has been obtained. At present we have only five from the United Provinces, about 30 from Bengal,[1] three from Mysore and the rest have been collected hurriedly from various parts of Madras, and include a fairly large number of introduced canes and seedlings from other countries. It is proposed to make the collection of Indian varieties a prominent line of work in the earlier years of the cane-breeding station's programme, this work being in a sense preparatory to the further testing of the seedlings as they emerge from their preliminary sorting.

[1] I am indebted to Mr. Woodhouse, Economic Botanist to the Government of Bengal for this fine series.

THE SUPPLY OF AGRICULTURAL CATTLE IN INDIA.

BY

C. E. LOW, C.I.E., I.C.S.,

Director of Agriculture and Industries, Central Provinces.

OUTSIDE his own family, there is nothing that fills so large a share of the cultivator's thoughts as his land and his cattle. The land is of little use to him without the patient creatures that till it, and though his treatment of them is not always conspicuously wise or humane, they are his constant companions in the field by day, and live beside his house, or even under his roof, at night. There are very few questions, then, that so closely affect the prosperity of the Indian cultivator as the maintenance of the supply of cattle and their proper care and treatment. The interest taken in these matters by the Indian public during recent years is a welcome sign that the people have begun to appreciate the necessity, to some extent at any rate, of self-help, even though many of the facts alleged are inaccurate and the deductions from them not entirely logical.

In particular, attention has been frequently called to the diminution in the number of cattle which is said to be taking place. Many reasons are given for this. The breaking-up of grazing grounds, the increase of forest dues, the spread of epidemic disease, the slaughter of cattle, are alleged to contribute to this result. It will be the object of this paper to give some statistical information regarding the cattle population of British India, and, after describing what is the present situation regarding the cattle supply, and examining the various economic features involved, to discuss the measures which Government are adopting to cope with the various causes which tend to a diminution in the number or efficiency of agricultural cattle; and

to venture on a brief forecast of the measure of success that is likely to attend them. Statistical information regarding agriculture has only in the last 20 or 30 years attained any real approximation to accuracy over a large proportion of British India. The portion of these statistics in which accuracy is most difficult to secure is perhaps the enumeration of cattle. Any person who has ever tried to obtain accurate information from cattle-owners about the number of their herds, or in default thereof, to count a number of active, jungle-bred animals, will quite appreciate the difficulties. But for some years past, an ever-increasing degree of accuracy has been secured, and the probable error in most parts of India does not now much exceed 5 per cent.

The statement below shows the total number of cattle in each of a series of selected years, the cropped area and population throughout British India. To make this statement clearer, the figure of the initial year has in each case also been expressed as 100, and that of each succeeding year has been reduced to the proportionate figure. The figures for Bengal, however, are quite unreliable for the earlier years of the period under consideration and have been excluded from the totals for British India given below :—

Progressive increase in cattle, cropped area and population in British India, excluding Bengal.

(All figures save percentages are in 000's.)

YEAR.	1885–86.	1890–91.	1895–96.	1900–01.	1905–06.	1909–10.
Nett cropped area (excluding Bengal)	128,283	138,265	135,487	146,708	155,452	170,862
Percentage ...	100	107·8	105·6	114	121	133
Total number of cattle (excluding Bengal) ...	53,921	73,378	78,581	84,434	91,130	94,903
Percentage ...	100	136	145·7	156·5	169	176
Total population of nearest census year (excluding Bengal)	152,141	171,926	171,926	180,890	180,890	191,590
Percentage ...	100	113	113	118·9	118·9	125·9

It would thus be clear, could these figures be entirely relied on, that the increase in the number of cattle has been much more rapid than in the cropped area and population. Even excluding the figures for Bengal, however, those of some of the provinces were not very reliable in the earlier years.

The figures for Madras and Bombay are believed to be more accurate, owing to the earlier introduction into those provinces of the reporting of cattle statistics.

Progressive increase in cattle, cropped area and population, in Madras and Bombay.

(All figures, other than percentages, are in 000's.)

Year.	1885–86.	1889–90.	1895–96.	1900–01.	1905–06.	1909–10.
MADRAS						
Total cropped area in acres	22,403	23,234	24,849	24,569	26,411	32,217
Percentage	100	103	110·6	109	117·5	143
Total number of cattle	9,403	14,488	15,594	15,057	16,538	20,089
Percentage	100	154	165·7	160	175·8	213·6
Total population	34,841	35,644	35,644	38,229	38,229	41,405
Percentage	100	116	116	124	124	134
BOMBAY						
Nett cropped area in acres	25,424	27,007	26,959	24,730	25,844	29,108
Percentage	100	113·7	106	97	101·6	114·7
Total number of cattle	6,865	8,293	8,489	6,688	6,714	7,571
Percentage	100	119	123·6	97	97·7	110
Total population	14,042	15,959	15,959	15,304	15,304	16,113
Percentage	100	113·6	113·6	108·9	108·9	114

The noteworthy point is that in Madras, which has not suffered from any severe visitation of famine in recent years, the cropped area exhibits a considerable rise, yet there is a still larger rise in the number of cattle. This is, perhaps, partly due to the extension of well irrigation in that province. In the case of Bombay, the severe distress before and after the year 1900-01 caused a fall in the cropped area, but the total number of cattle has not declined in any greater proportion.

Confining our attention entirely to the years since and including 1905, for which figures are fairly accurate, it is clear that the number of cattle have more than kept pace, over India as a whole, with the cropped area. But it is hardly necessary to take refuge in statistics to prove so patent a fact. It is clear that there is a limit to the number of acres which a pair of oxen can cultivate. If the number of cattle fell short, by any appreciable quantity, of the number required to till the area under crop, it is clear that the number of acres tilled per head of cattle cannot be indefinitely increased, and there must inevitably be, sooner

or later, a decline in the cropped area, unless the agricultural practice materially deteriorated or the quality of the cattle greatly improved, neither of which, it is well known, has been the case. On the contrary, the cropped area, in spite of occasional set-backs due to famine, has been steadily rising, and this shows, plainly enough, that there has been no decline in the number of cattle. Those officers who have had experience of severe famine conditions know well how immediately a fall in the number of cattle is followed by a fall in the cropped area. The question is not entirely one of statistics however. For the total number of cattle reported includes, and always has included, a large number of useless beasts that eat up the food required by the more valuable animals. Any cause that tends to diminish the number of such animals is a positive benefit to Indian agriculture, and, though it may be a matter for regret that the slaughter of even the very small proportion of cattle that meet this fate every year should cause pain to our Hindu fellow-subjects, it is far from being injurious to Indian agriculture.

In contrast to the somewhat doubtful lessons to be learned from figures, one fact at any rate is generally admitted, and that is, the increase in the price of cattle. In view of the general rise in the value of land and all its products, it is hardly worth while, perhaps, considering in very great detail the causes of this: but, put quite briefly, the history of the rise seems to have been as follows. Cattle owners originally relied mainly on grazing grounds. Owing to the increase of population, and the rise in prices, an ever increasing share in the waste is being brought under cultivation: and at the same time the extended cultivation requires more cattle to carry it on. There is another aspect of the question, and one which appeals more strongly to the town dweller. Cattle and fodder being alike dearer, the price of milk has naturally risen in sympathy, bringing in its train adulteration and other evils. It seems probable that tuberculosis is on the increase among certain classes of the town population. How far this is due to deterioration in the milk supply is a question for serious consideration.

The breeding of cattle is carried on partly by cultivators in their villages, partly in forest or other large grazing areas by professional graziers. In the first case, the cattle in some parts of India tend to deteriorate. The breeding animals are ill-fed and ill-tended. No care is taken to select the best type of bulls, or to keep the different breeds separate: and the tendency is to approximate, not to the type of animal which can give the best return in work in proportion to its cost and its keep, but to a starveling wretch, whose only recommendation is that it can live on a minimum of food and pick up a living where a better animal would starve. But this is by no means always the case: and in the better cultivated areas, especially where irrigation is available, there are not wanting signs that stall-feeding is on the increase. The greater cost of cattle is leading their owners to take more care of them, and the extension of the practice of stall-feeding tends to bring about a rise in the value of fodder crops, which the cultivator now finds it more profitable to grow. The increasing pressure on the forest areas available for grazing is necessitating the division of the Government forests into grazing units, and the fixation for each of these of a limit on the number of animals that can be allowed to graze there. This action on the part of Government evokes constant criticism: but to continue the unrestricted admission of cattle to Government forests would have the result in a very few years of leaving the forests with little or no grazing value. An increase in the fees charged for grazing is only fair, considering the great rise in the rates charged for grazing by private land-owners, and the ever-increasing pressure on the forests.

After this statement of the case, it is now permissible to discuss the lines which we should follow to secure the improvement of cattle and an increase in their number. The economic tendencies which, as has been explained above, are already beginning to show themselves, give the surest indication of the most natural and safest policy to follow. We have now reached, as has been well said by Mr. Moreland, a state of approximate equilibrium. In areas where stall-feeding is already practised,

the number of cattle fluctuates over periods of three or four years, according to the character of the seasons. A dry year means less fodder; cattle have to be sold from lack of food; if they do not actually die of hunger; and the next year shows a considerable diminution of stock. This, however, corresponds with a diminution in the supply of agricultural capital, and a decline in the cropped area, conditions which to some extent balance one another. Better seasons increase the supply of cattle, as well as the cropped area and the capital available to cultivate it. In areas where cattle rely mainly on grazing, it is unusual for a failure of the rains to cause any considerable diminution in the number of cattle, simply on account of the shortage of natural fodder. But, on the other hand, the average quality of the cattle tends to fall as the grazing area diminishes, and it is clear that there is no finality in such an arrangement.

What is required, then, is an extension of the practice of stall-feeding, under circumstances which will secure in all years an adequate supply of the necessary food. In irrigated areas, the solution is in sight. There are numerous fodder crops suitable for different localities; Egyptian clover and lucerne under favourable circumstances will give a heavier yield of fodder than any other crop, as they can be cut about four times in a season without much decrease of the yield at each successive cutting. On one of the Central Provinces' farms Egyptian clover gave 19,000 lbs. of green fodder per acre for a single cutting. In Egypt, it forms the favourite rotation with cotton, but its great drawback in India is the small amount of seed that it produces. This may be due to climatic causes, or to the absence of fertilising insects. Several of the millets, especially those grown in the *rabi* season, give heavy yields of fodder under irrigation, but they do not yield much after the first cutting. Other cereals, such as oats, and wheat cut green, or pulses, following on rice, are also favourite fodder crops. Irrigated pasture, which is already beginning to find favour in the Punjab, is another alternative. But over most of India, the cultivators of the more backward irrigated tracts have not yet

reached a stage at which they are prepared to grow fodder crops instead of pulses or linseed, which they can sell for cash.

Undoubtedly the supply of dairy products in large centres of population is mainly a question of irrigated fodder combined with heavy manuring, and this point will be reverted to later.

Were it practicable to bring the whole cultivated area of India under irrigation, the question of cattle-feeding could soon be solved. But the Indian public have learned by now that this is out of the question: and it is necessary to consider the best methods of dealing with areas where irrigation is not available. In such an area, millets and pulses are the main stand by. In years of ordinary rainfall the supply of the former, at any rate, is usually in excess of the demand: and the surplus is habitually sold or wasted. An efficient method of storage is required. Experiments in Berar have shown that *juari* stalks can be stored successfully for more than one year with little or no loss, if carefully stacked: and it should be possible to form a reserve of fodder in this way, consuming it as soon as the new crop was ready, and storing the latter in its turn, so as to place the cultivator beyond the fear of anything but a long continued series of dry years. The main objection to this proposal in the popular mind seems to be that the possession of stored fodder tempts a hostile neighbour to revenge himself by setting light to the stack: but that concerns a branch of administration which is beyond the scope of the Agricultural Department. Ensilage is a possible solution of the difficulty attending the supply of fresh fodder in the hot weather, but it is of little use for storing fodder over from one year to another. Oil-cake is an invaluable adjunct to bulky fodder in all tracts and can be obtained far more cheaply from a mill than from the local *teli*. But there is still a prejudice amongst many cultivators against the hard mill cake, with the result that the Indian mills have, in most places, to send their cake to England for sale. It costs a great deal less to send a ton of oil seeds to Calcutta or Bombay than the cake and oil into which they can be manufactured: and it would seem only right for the railways to reduce this difference

as far as possible by lowering the freight on cake, which is at present placed by most railways in the same class as food grains: this would render it available over a much wider area either as a cattle food or as a manure.

There remains the question of the best method of dealing with the grass produced in Government forests. It is at any rate certain that it is much more economical to feed the grass than to graze it; and the policy of the Central Provinces Forest Department is now 'cheap grass and dear grazing.' The cultivators of the Nimar district have for some years past fed their cattle on cut grass brought from the forests, instead of sending them to graze. The forest officers of this province have had considerable experience during the past year in supplying the famine-stricken cattle of Gujerat: and, in spite of difficulties caused by dearth of railway wagons and lack of labour, have achieved a considerable degree of success. It seems undoubtedly the case that almost any variety of grass, when cut early in the season, furnishes a nutritive fodder: this has been proved by experiments with spear grass (*Andropogon contortus*) in the Raipur district. The grass must be cut as rapidly as possible, and properly cocked to protect it against any rain that may fall. Grass cutting by hand is a slow operation, and the coolies employed are not ready to learn new ideas. The use of a machine is thus necessary to ensure quick cutting: and, even where this is not essential, a machine works so much cheaper that it would pay the Forest Department to use it where the ground is suitable, even at the cost of removing a considerable number of stones and stumps. If a regular export demand can be created, it is easier to expand the ordinary annual operations to meet a sudden famine, and there would be little difficulty in storing grass in large quantities, so as to keep in hand a sufficient supply to meet a year of famine. For the rest, those forest areas where no effective demand for grass exists should be made available as breeding areas. A number of such areas are being selected by the Forest Department of the Central Provinces, with the idea of throwing them

open to enterprising capitalists who are prepared to maintain a proper number of cattle of good type. No restriction will be placed on sales; and easy terms will be offered at first. Where definite and suitable breeds exist, the type aimed at by the owner of a breeding farm should be one or other of these; and Government will, as far as possible, endeavour to select and maintain small herds of each of the best local breeds, to serve as a nucleus for the private breeding farms. Continued action along these lines cannot fail to improve agricultural cattle generally, while selecting the type best fitted to its environment in each case.

Much has been done of late years to control the inroads of infectious disease. The statement below exhibits briefly the work of the Civil Veterinary Department in respect of bovines:

Year	Number of Cattle [illegible]	Number treated otherwise than by inoculation.
1908–09	317,032	583,246
1909–10	251,072	701,897
1910–11	360,273	752,885

The number of animals inoculated varies according to the extent of infectious disease; but the common ailments vary little from year to year, and the increase in the number of animals treated shows a real readiness on the part of the people to avail themselves of the increased facilities offered them by the Veterinary Department. The great difficulty at present is, the length of time that reports of infectious disease sent in by village officials take to reach Veterinary dispensaries. What is wanted now is that cattle owners should report, direct to the nearest Veterinary Assistant, as a matter of course, the occurrence of infectious disease, not only among the cattle of their own village, but in their immediate neighbourhood, and that a healthy public opinion should arise on the subject of segregation: some signs of this are already apparent, especially in Burma. But there is an urgent need for an increase among the gazetted

staff of the Veterinary Department. An extended and improved College training for Indians and a more liberal recruitment of the European staff are alike necessary, if the Department is to bear its increasing burden of responsibility.

A brief mention of the dairy question must suffice. Apart from the rise in the price of cattle and cattle food, and the export of *ghi*, all of which are causes which tend to make dairy produce dearer, the milk supply in towns is in a transition state. Not long ago, a large proportion of town dwellers kept their own animals. They perhaps did not feed them very well, or treat their milk in the most sanitary manner, but the present state of affairs is a great deal worse. The supply of dairy produce is in the hands of dirty and dishonest milk-sellers, while competition is on the part of customers, rather than of vendors. We are passing from the period of domestic to that of organised professional supply, and states of transition are proverbially uncomfortable. The remedy lies in the provision of green fodder by irrigation and high manuring, both of which are nearly always possible near large towns: and, when this has been accomplished, in legislation and inspection to prevent dishonest dealing and insanitary conditions. There are well founded complaints about the adulteration of milk and *ghi*. It was recently found at Nagpur that most of the milk sold by vendors in the city was diluted, in some cases to the extent of 60 or even more: while, though much of the locally produced *ghi* was a *kanchi ghi* article, adulterated *ghi* from Bombay, where legislation exists to prevent its local sale, was coming in in large quantities. The sale of a mixture of *ghi* and vegetable oils, provided the sellers clearly declare the nature of the article at the time of sale, is unobjectionable: and a cheap and wholesome *ghi* mixture of this kind would be a boon to the poorer classes.

The trade in cattle and dairy produce is thus, while by no means in an ideal condition, at any rate moving from the old simple domestic stage of production, to the more elaborate and specialised system of modern times, and the course of development seems on hopeful lines. It may be argued, however, that

there is no real ground for this optimistic view, and that it is just as legitimate a conclusion from the facts, that things are going from bad to worse. To rebut this, one has only to turn to the economic history of almost any modern country. In England, up to the 17th century, there was no stall-feeding of cattle, except to a small extent in the case of animals actually working at the plough. The general practice of agriculture did not include fodder crops, and the animals relied for what little food they received in the stable, on the hay cut from the very few meadows, shared out in tiny strips among the cultivators of an English township. With all the arable land held in similar strips, averaging half an acre in size, with few or no enclosures, and with the cattle wandering over the stubbles and village waste, picking up a miserable subsistence from the close of the harvest to early spring, the growth of fodder crops, the proper breeding of animals, and the prevention of infectious disease were alike impossible. Animals were in their best condition in September, for the poor living which was obtainable throughout the winter reduced them to mere skin and bone. The state of affairs in rural England closely resembled, in this respect at any rate, that of the very poorest Indian rice districts.

The alteration was brought about, first of all, by the gradual amalgamation of holdings and the enclosure of fields with fences and hedges, an end long thought desirable, but rendered impossible of attainment by the sub-division of land and the scattered nature of the holdings. The practice of enclosure made the growth of fodder crops possible, and it was not long before, following the example of the Dutch, turnips and clover, two of our most valuable species of fodder, were introduced. The better feeding of cattle gave more manure and better tillage, these produced better crops, which enabled the cultivators to buy better cattle and feed them more liberally. These causes continued to interact, until at the present day the cattle weigh nearly three times what they did at the beginning of the 17th century, while the sheep produce between 3 and 4 times as much wool, and the cereal crops give from 3 to 5 times the outturn. Though it is to

be hoped that India may be spared the awful visitation of the Black Death, which accelerated these inevitable economic changes in England, the former country is now in a much more favourable position for the inception of an improved agriculture, than was England in the fifteenth century. The landlords' holdings are not, in most parts of India, as they were almost everywhere in England, divided up into half acre plots, scattered over every part of the village : while the tenants' fields also are in many places of fair size. There are plenty of roads and railways to carry off the surplus produce of the country villages, so that the country does not alternate between the pinch of famine and the curse of wasteful plenty to the extent that was the case in medieval England, or even in modern India till recent years. The experience of a nation which has met and overcome these and other difficulties with much loss and painful effort and by their own unaided exertions is at the disposal of the Indian people to lighten their journey along the toilsome path of progress, if they will listen to the voice of friendly counsel. Signs are not wanting among Indians of to-day, not only of a greater readiness to do so, but of a conscious effort to work out their own salvation, to utilise to the full the knowledge of the West, and apply it to the solution of Eastern problems, and, given self-help and good advice, the prospect in the direction where the economic experience of the past already points the way seems full of promise for the future.

THE CATERPILLAR PEST OF THE MOKAMEH *TAL* LANDS.

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ALTHOUGH for the last fifteen or sixteen years the winter crops have been destroyed annually by insects over an area of some ten or twelve thousand acres of the Mokameh Tal, it was only in December 1909 that attention was called to this loss. The Patna Divisional Agricultural Association was at that time desirous of building embankments and sluice gates to retain the water on the land, so that sowings might be delayed until the cold weather had set in with the object of avoiding damage to the crops by the insects concerned. Attention having thus been drawn to the matter, it was found that the loss was being caused by Surface Caterpillars (*Agrotis ypsilon*), and it was

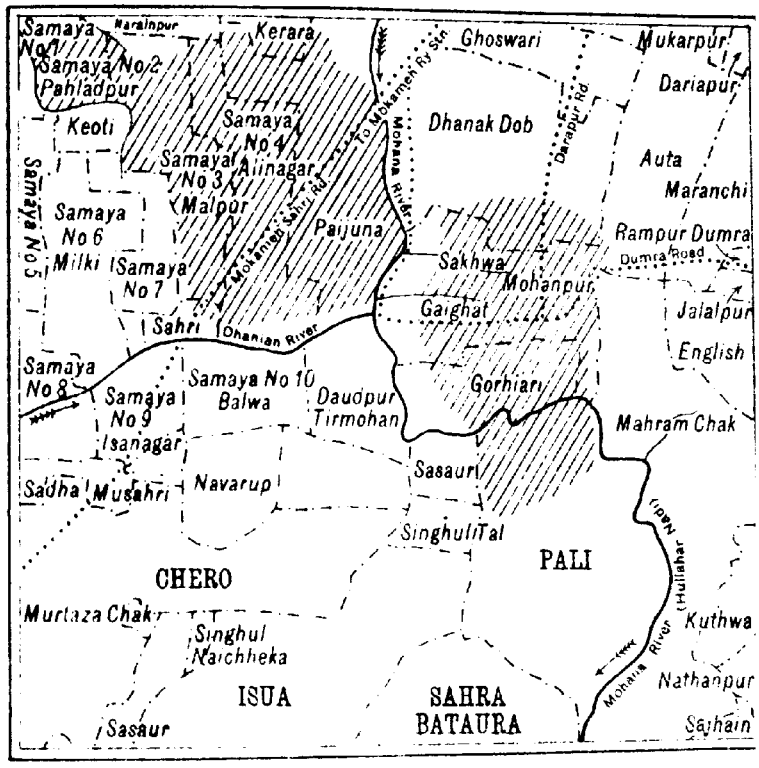
[These operations in connection with the outbreak of *Agrotis* caterpillars on the Mokameh *Tal* lands have been carried out by the Agricultural Department of Bengal (now Bihar), under the Economic Botanist, and have throughout been done in close touch with Pusa. In 1910 Mr. Maxwell-Lefroy, the Imperial Entomologist, visited the area and took an active share in the work. In 1911, as Mr. Lefroy was away on leave and I was officiating for him, some small opportunity of helping in these operations fell to my share, and at the conclusion of the campaign I suggested to Mr. Woodhouse that a short account of the work done, written by us jointly, might be of interest to readers of the Agricultural Journal. To this Mr. Woodhouse cordially assented and, as he was then just on the point of leaving India on leave, he handed to me a copy of his notes on the past campaign and requested me to prepare a joint note for the Journal. The present article is the result. For any shortcomings in it I am responsible. Mr. Woodhouse described the earlier operations of 1909 and 1910 in the Bengal Quarterly Journal, Vol. IV, No. 4 (April 1911) and I have not hesitated to draw upon this for an account of the earlier work. Any credit for the work and its results is due to Mr. Woodhouse and his Staff.—T. B. F.]

pointed out to the Divisional Association that the proposed system of embankments would only lead to useless expense because this particular insect is active and breeds continuously throughout the cold weather, so that delay in sowing these lands would not be likely to exempt them from attack.

The particular area in question comprises about forty square miles in all, and lies due South of the Mokameh and Burhi Station.

The soil is a stiff clay and the whole of this land is inundated annually to a depth of from five to fifteen feet during the rainy season from June to September, in which month the water recedes concurrently with the fall in the Ganges, being drained off by the Mohana River. The land on the whole is flat but some portions are slightly higher than others, and these more elevated patches are usually exposed above water and ready for ploughing towards the end of September. Cultivation can be commenced about ten days after the water has receded from the land and can be continued for about fifteen days, after which the ground becomes so hard that it cannot be ploughed. Ploughing breaks the earth into humps varying in size from that of a pea to that of a man's head. The individual holdings vary from 2.5 to 709 bighas,[1] and there is one plough to every 30 bighas, each plough being expected to work 1½ to 2 bighas a day. The cultivation consists in ploughing and sowing the land with *a toor*, the seed being dropped into the plough furrow by means of a hollow bamboo attached to the plough. For this a pair of bullocks and two men are required. The fact that the land does not all dry simultaneously enables the sowing to be carried on for at least a month, though every year some land is necessarily left fallow owing to its hardening before it can be ploughed. After sowing the land receives no further cultivation until harvest, the cultivators, who are low-caste Hindus and many of whom live in Mokameh and only visit their lands for the purpose of sowing and harvesting their crops, resting in their houses or going elsewhere

Map showing area normally attacked by AGROTIS



Scale 1 Inch = 2 Miles

REFERENCES.

Mauza boundary

Road

River

Attacked area

for the rice harvest. The crops chiefly sown are *masur* and *khesari*, with some peas on the higher lands. The low lands are absolutely bare of vegetation when sown, although various small plants spring up later, and amongst these are two weeds called *hurrur* (*Cleome viscosa* and *Gynandropsis pentaphylla*), which are connected with the attack by the cultivators, although as a matter of fact these are the only plants not eaten by the caterpillars.

The same pest has also been reported from Colgong and Pakur, where the conditions are practically the same, but the areas affected are not so large, and in the case of Pakur the soil is much lighter.

As noted above, the outbreak of *Agrotis* in 1909 was not reported until December, by which time the damage had been done so that no practical measures remained to be adopted that year. It was suggested, however, that experiments should be carried out in 1910 regarding the value of putting out baits of a mixture of white arsenic, sugar and *bhusa* (bran), and that *the efficacy of hand-picking and of making deep conical holes as* traps should be tried. In pursuance of this policy a meeting was arranged at Mokameh on 6th September 1910, and this was attended by the Collector of Patna, the Imperial Entomologist, and some Zamindars and a number of cultivators. These last agreed to try the baits in spite of their being poisonous, and an experimental plot of about 1,000 bighas was decided upon. It may be said at once that the poisoned baits were laid down under considerable difficulties over 125 bighas, but that they proved a total failure.

As a result of the late rains in 1910 the water did not begin to recede from the experimental area until 19th October, and it was not ready for cultivation until 30th October. On 22nd October no trace of the caterpillars could be found on the higher lands already ploughed; an acetylene lamp-trap was tried but no *Agrotis* moths were caught. On 31st October the Tal lands were again visited, when the experimental area was being sown, but no caterpillars could be found there except a

few small larvæ of *Prodenia litura* (*littoralis*) on the unploughed portion. A few bighas of peas which had been sown on 19th October were however found attacked by *Agrotis* on the higher land: it was found quite easy to find the caterpillars amongst the clods at the base of the withered shoots, so it was determined to hand-pick this area, and 206 caterpillars were collected. On 4th November a new attack was reported near Tirmohan village and 1,081 caterpillars were collected on that and the two following days. The acetylene lamp-trap was tried nightly until 6th November, but no *Agrotis* moths were captured. By 9th November about six bighas were reported as attacked at Sahri and about twenty bighas at Kanera. After heavy rain on 11th and 12th November it was found on 14th that *Prodenia* caterpillars with a few *Agrotis* had suddenly appeared over some 200 bighas. Dusting of the plants with Lead Chromate was tried but failed owing to strong westerly winds: several thousand caterpillars were, however, collected by hand. Small patches of the worst-attacked areas were also ploughed, beamed and resown. Between 20th and 26th November blocks of land were marked out beside the Tirmohan Road to demonstrate the efficacy of hand-picking of the caterpillars: as a result it was found practicable to hand-pick badly attacked areas at the rate of Rs. 3 4/- per acre. The caterpillars in block 1, close to the original *Prodenia* attack, were found to be in the fourth stage, a few *Agrotis* being in the first stage, whilst in block 2, at a distance from the *Prodenia* attack, the caterpillars were nearly all *Agrotis* and were in the second or third stage only. The cultivators appeared satisfied that hand-picking was possible and said that they would hand-pick their crops next year.

On 26th November the low lands on both sides of the Tirmohan-Darapur Road were found to be slightly attacked by *Agrotis*, over a very large area. On 29th November a report was received that the whole of Pali Tal was attacked by *Agrotis*. On 9th December a final visit was paid to Mokameh Tal, and it was found that the whole of the land on both sides of the Darapur Road as far as Tirmohan was badly attacked by *Agrotis*, and that an equally

large area of Paijuna Tal had also been completely cleared, the *Agrotis* being then three-quarters grown. Next day Burhi Tal was visited and some small areas near Mohram Chouk were found damaged by *Agrotis*, then about half-grown, whilst the whole of Pali Tal appeared to be badly attacked by *Agrotis* caterpillars, which were from a quarter to nearly full-grown.

The damage done in 1910 was reported by the Sub-Inspector of Police, Luckiserai, as 4* annas damage over 10,000 bighas, and 2 annas damage over 4,850 bighas. Practically the whole of this loss was caused by *Agrotis*, some 200 bighas only being cleared by *Prodenia*.

The experience gained in 1909 and 1910 had shown the possibility of controlling the pest to some extent by hand-picking, and it was obvious that every effort should be made in future years to tackle the first brood as soon as it put in an appearance on the Tal lands so as to prevent the subsequent multiplication of the pest as far as possible. As each female moth may lay anything between 100 and 500 eggs and as the whole life-cycle may be passed through in a month or little more, it will readily be seen that the destruction of a single member of the first brood means the destruction of thousands of its potential progeny: assuming, for the sake of example, that each female moth lays 300 eggs (a modest average), then in the second generation (November) we shall have 45,000 caterpillars producing 22,500 female moths, which are the parents of 6,750,000 caterpillars in the third generation (December). The assumption is, of course, that every individual survives and no allowance has been made for reduction by parasites, enemies or diseases: but, on the other hand, a comparatively low rate of increase has been selected (only about sixty per cent. of the possible), so that the figures given above are perhaps not so very wide of the mark after all.

A problem which at once presented itself in connection with the destruction of the first brood of caterpillars was the question

* The expression '4 annas damage' means damage to the extent of 4 annas in every rupee's worth of a normal full crop, *i.e.*, that one-quarter of the whole crop was destroyed.

of the origin of the parent moths. As we have seen, the Tal lands have been inundated to a depth of many feet for three or four months so that it seems incredible that the moths could survive in the ground at any stage of their existence and bear submergence for so long a period. Yet, immediately the land dries—immediately, we may say, that it emerges from the river, there is an influx of moths ready to lay eggs. Whence do they come? No *Agrotis* moths are to be found in any stage in the surrounding plains after about March or April, when the dry hot weather has set in, nor are any to be found until about the beginning of October when the rains are over and the temperature begins to fall again. In Egypt, where *Agrotis* is only active in the cold weather in a parallel manner, it has been found that the caterpillars which are full-fed at the end of the winter enter the ground then and remain in a resting-stage until the end of the hot summer, when they pupate and the moths emerge as soon as the cold weather sets in. In Egypt, however, the conditions are very different as regards the state of humidity of the ground, and it seems extremely unlikely that in India these *Agrotis* caterpillars could survive in a similar resting-condition during the rains—at least, in the Gangetic Plain, where the soil is practically waterlogged at this season. Moreover, it must again be pointed out that the Tal lands, which are so peculiarly susceptible to attack, are flooded to a depth of several feet for months at a time.

Under these circumstances, it seemed to us likely that the moths migrate from the plains to the hills at the end of the cold weather and breed in the hills during the summer and that their descendants migrate again from the hills to the plains as soon as winter sets in. Such a theory seems at first sight rather fantastic, but we have solid reasons for believing that a similar migration is performed by other insects (*e.g.*, the Cabbage White Butterfly: *vide ante*, p. 2). The *Agrotis* moth is a strong-winged insect with such vagrant tendencies that it has found its way over practically the whole of the world, and a comparatively short journey to and from the hills would be

well within its powers of flight. It was thought possible that the Parasnath Hills, 250 miles to the South of Mokameh, might form a breeding-place during the summer months and accordingly, in May 1911, Mr. C. S. Misra, First Assistant to the Imperial Entomologist, visited these hills to try and discover whether it was breeding there. The search, however, proved abortive: the weather in the hills at that season was extremely hot and dry and no moths could be found in any stage. The migration-theory, therefore, remains to be proved. It is, of course, possible that the migration is only in one direction from the hills to the plains in September-October, and that there is no return flight in March-April. Certainly in these latter months in 1912 numerous dead *Agrotis* moths were noticed at Pusa and these seemed to have died from natural (? climatic) causes.

As regards the reason why the Tal lands should be so susceptible of attack, it has been suggested that the newly-uncovered mud possesses some peculiar attraction (probably smell), for the female moths, and that they are so attracted* and lay their eggs on the mud, especially when it has been disturbed by ploughing. Some such hypothesis is required to explain the fact that the caterpillars are ready to attack the newly-sprouting crops, although the ground has previously been bare of vegetation. During a discussion on the attraction of the moths by smell and the methods by which this might be turned to account, it was further suggested that a trial might be made of the moth-trap recently used in Egypt for the control of some of the moths which attack cotton. It is said that, some time in the "forties" of the last century, a grocer who was a keen entomologist noticed that moths were attracted in the evenings to the empty sugar-barrels stacked in his yard, and his observation soon led to a regular system of attracting moths by a mixture of sugar, treacle and beer smeared upon tree-trunks in their natural haunts. This is the basic principle of the

* The attraction which newly-turned earth has for various species of flies is a matter of common observation.—T. B. F

moth-trap invented by Messrs. Andres Maire et Cie., of Alexandria, for use with an attractive liquid called "Prodenine," specially produced by them to destroy the moths of *Prodenia litura* (*litteralis*), whose caterpillars attack cotton in Egypt. Two of these traps were procured from Egypt, together with a supply of *Prodenine*, but, owing to delay in delivery, they arrived too late to be of much use for the capture of the early egg-laying *Agrotis* moths in 1911.

THE ANDRES-MAIRE TRAP WORKED AT PATUNA, NOVEMBER 1911.

In 1911 the campaign commenced on 20th August when the Sub-Divisional Officer, Mr. J. G. Drummond, held a meeting of zamindars and cultivators of the Tal at Mokameh, but the attendance was poor on account of rain. The nature of the pest and the remedies suggested were fully explained and leaflets distributed. As a result of the meeting it was decided to take further steps to obtain the co-operation of the zamindars and to impress on all the cultivators of the Tal the importance of

destroying the first brood of caterpillars appearing on the higher lands.

Owing to the fact that the rains continued until late again this year (1911), the land remained under water until about a month later than usual, and the ploughing of the higher lands did not commence until 16th October. A search of these higher lands for *Agrotis* caterpillars was started on 20th October and three days later the first caterpillar was found by Mr. Drummond on the higher land near Malpur and on 24th October caterpillars in the second, third and fourth stages were found there. With a view to enlisting the help of the cultivators in the collection of these early caterpillars, a reward of five rupees had been offered to everyone bringing in information of a first brood of caterpillars on the high land; but these rewards were never claimed, the cultivators steadily refusing to look for caterpillars or to pick them before their lands were ploughed and sown. As noted above, there is indeed very little time for the performance of these operations, which must be carried out before the land dries too much, and it is scarcely to be wondered at that the cultivators should be reluctant to waste (as it must seem to them) valuable time in searching for caterpillars which are still scarce and doing no damage as yet.

On 28th October 1911, 210 caterpillars in the third to fifth stages were found at Paijuna Basti on high land from which the water had receded on 27th September and which had been sown on 12th October. Hand-picking was continued here until 12th November. On 28th October a caterpillar in the fourth or fifth stage and one in the second stage were also found in Sakhoa on some lower lands which had emerged about 7th October and which had since been sown. From this day, on which the Collectorate Staff and Divisional Agricultural Inspector arrived at Mokameh and Pali, picking of the first brood was commenced in earnest and continued for the next fortnight.

The Andres-Maire traps were only received at the very end of October, but henceforward they were worked regularly

every night with good results. About eighty per cent. of the *Agrotis* moths captured were females and of these the majority were unfertilized or, at least, their eggs were not ready for extrusion. A record of the moths caught in the Paijuna trap is shown in graphic form in the chart opposite. Monthly abstracts of the results give the following record :—

Period.	*Agrotis* (male).	*Agrotis* (female).	*Prodenia*.
31st October to 30th November	516	2,268	668
1st December to 31st December	85	206	45
1st January to 31st January	139	520	391
1st February to 29th February	253	604	628
1st March to 31st March	19	52	30
TOTALS	1,012	3,450	1,732

Thus it will be seen that a total of 4,462 *Agrotis* moths was caught in this one trap during a period of five months, and of these roughly three out of every four were females. These figures speak for themselves and it is very unfortunate that the traps should have been delivered too late to catch the first egg-laying females.

Between 28th October and 11th November it is also estimated that 62,699 *Agrotis* caterpillars were hand-picked and destroyed. After the latter date it was decided to discontinue organised picking as likely to prove uneconomical. At this time about seven caterpillars per square yard were to be found in badly-attacked areas, and one caterpillar in each square yard of the areas more lightly attacked. Thirty-five thousand caterpillars are estimated to be capable of totally destroying one acre of crop.

It is not possible to give any accurate figures for the amount of damage done in 1911 as compared with that in previous years. All those who know the Tal, however, are agreed that the amount of damage done in 1911 was very much less than usual. Areas on which the crops had been totally wiped out for the preceding ten years bore over most of the land a crop estimated to yield an out turn of from a quarter to a full

crop, only a few scattered fields having been totally destroyed. The cultivators as a whole do not ascribe the lessening of the damage to the work done by the Agricultural Department, but to the fact that the floods receded late and so enabled them to delay their sowings and to the good rainfall in November. That their explanation is incorrect is proved, however, by the fact that the season of 1911 was exactly similar to that of 1910; the water receded on 19th October in 1910 and on 16th October in 1911, and heavy rain fell on 11th and 12th November 1910 and on 13th and 19th November 1911. Yet in 1910 the attack was of normal severity and comprised some 15,000 bighas which were a total loss, whilst in 1911 the total damage may fairly be estimated as not exceeding 5,000 bighas. It is perhaps pardonable to ascribe the saving of the difference of 10,000 bighas as due in large measure to the campaign conducted by the Agricultural Department. During the coming season of 1912 it is proposed to make further and more extensive trial of the Andres-Maire traps. These will be worked on the higher lands from about the end of August and will be gradually moved down on to the lower areas immediately the water has receded from these. By this means it is hoped to obtain more definite information regarding the movements of the parent moths, and also to catch these before they are able to lay their eggs. A careful look-out for caterpillars on the highlands will also be kept and, in case any appear, they will be destroyed by handpicking in the usual way.

Summary.

For the last fifteen years or so the winter crops on about ten thousand acres of Tal land near Mokameh, on the southern bank of the Ganges near Patna, have been destroyed annually by *Agrotis ypsilon* caterpillars. These lands are flooded during the rains to a depth of several feet and are ploughed and sown as soon as the water recedes. The moths are apparently attracted to the wet mud, and lay their eggs there, and attack the crops as soon as these spring up, rapidly increasing in numbers until the whole crop is totally destroyed. This damage was

reported in 1909, but the caterpillars had then already increased to such an extent that no remedial measures were of avail. In 1910 trials were made of handpicking of the caterpillars, the use of poisoned baits, dusting the crops with Lead Chromate, and light-trap; of these all were found useless except handpicking which was considered efficient if properly organised. In this year practically a normal amount of damage was done. In 1911 systematic handpicking of the caterpillars was adopted as soon as they appeared and over sixty thousand of the caterpillars of the early broods were thus destroyed before the middle of November. Trial was also made of the moth-traps produced by Messrs. Andres Maire, Alexandria, and over two thousand female *Agrotis* moths were caught in one trap during November. As a result of these measures it is claimed that over six thousand acres of crops were saved. Further and extended trials of these traps and of handpicking will be made during the coming season in 1912.

AN ADDRESS DELIVERED AT THE TIRUPPUR CATTLE SHOW TO THE COIMBATORE DISTRICT AGRICULTURAL ASSOCIATION.

BY

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WELL IRRIGATION.

ADDRESSING an audience, the majority of whom are Coimbatore agriculturists, it is unnecessary to dilate upon the importance of well irrigation in this district. That this is fully recognised is disclosed by the fact that, whilst at the beginning of the last century there were about 20,000 wells in this district, there are now nearly 80,000 and they irrigate in a normal year about 300,000 acres. These wells, the result of the labour of generations of ryots, are an asset of great value. In the Coimbatore District Manual, prepared by Sir Frederic Nicholson and published in 1887, he writes :—"During the past 30 years about 26,000 new wells have been dug, representing a capital of, say, Rs. 65 to 70 lakhs." This indicates an average expenditure of Rs. 250 per well. During the scarcity of 1891-92 advances to the extent of Rs. 8 lakhs were made for digging wells and upwards of 5,000 wells were then dug, from which it would appear that the average expenditure on each well was Rs. 160, but this probably does not represent the total expenditure in labour or money that was incurred on these wells. It is practically certain that the average well in the Coimbatore district could not now be dug for less than Rs. 500, and it is equally certain that they are fully worth that amount to the cultivator. We may, therefore, assume that the wells of Coimbatore are an asset which may be valued at not less than Rs. 4 crores. It is well to pause and consider what this vast sum means. It represents a capital outlay of Rs. 133 per acre under irrigation, and invested at 6¼ per

cent., the rate charged by Government for *takkavi* loans, it would yield a return of Rs. 25 lakhs a year, equivalent to a charge of more than Rs. 8 per acre per annum on the area dependent on the wells. But this is a comparatively small item compared with the expenditure necessary to lift water from the wells.

The Cost of Lifting Water.

A short time ago I published some data tending to show that the cost of lifting water in Coimbatore averaged Rs. 70 per acre per annum, but to this high figure the officers of the Agricultural Department took exception, and we discussed the available data very carefully, with the result that my original estimate was not materially discredited. The conclusion we came to may be briefly stated in the following terms. The lifting of water for the 300,000 acres under the wells in the Coimbatore district roughly costs the ryots in some form or other the equivalent of between one and a half and two crores of rupees. Whether the higher or the lower estimate be accepted, it will be admitted that the burden is an exceedingly heavy one and can only be met by the unceasing toil of the ryot on what was, however, originally a rich soil, and which is kept in a very fertile condition by a highly developed system of culture. It is the object of the Agricultural Department to assist the ryot to still further improve his methods of cultivation, and it is the object of the Pumping and Boring Department to endeavour to reduce the expenditure which the ryot must incur before he can make use of the water which drains into his well. One Department is endeavouring to increase the gross yield of the land and the other to diminish, as much as possible, the cost of supplying water. The efforts of the Agricultural Department will probably, in some form or other, be of benefit to every cultivator of the soil, but in the immediate future I can hold out no hope of doing anything to assist the majority of the ryots who are lifting water from wells.

We are endeavouring to introduce mechanical methods of lifting water in place of those which involve the necessity for employing cattle. So far there have been installed in this district between 40 and 50 pumping plants, the smallest of which

is capable of raising 10,000 gallons of water per hour, and if worked for 12 hours a day, will supply about as much water as can be taken out by 10 mhotes. Each mhote irrigates on an average 2½ acres of land and a 3" centrifugal pump driven by an engine of power suited to the height to which the water has to be lifted should suffice, working a day of 12 hours, to irrigate 25 acres of land. Probably, however, such a good result as this is not usually obtained, as our experience shows that when ryots avail themselves of mechanical means for lifting water, they do not exercise the same care in distributing the water over their fields as they do when working with the mhote, and consequently they do not work so economically.

For a long time I have been trying to introduce mechanical working on a smaller scale than is economically possible with centrifugal pumps, and this year I have induced Messrs. Massey & Co., of Madras, to exhibit the result of our joint labours. Most of you have probably seen it at work in the exhibition yard, and you will have observed that it consists of a 3½ H. P. oil engine, driving through suitable gearing a pair of loose piston pumps. Each pump is 6" in diameter and the pair are capable of lifting about 6,500 gallons of water per hour from a depth of 40 feet. The pump now exhibited is the largest size we intend to make, as it is not proposed that it should be used in place of centrifugal pumps when the quantity of water available justifies their employment. I have recently received a report from one of my supervisors who has erected a pair of these pumps on a well in the Krishna district. These pumps are 5 inches in diameter and are driven by a 2 H. P. engine and on a lift of 29½ feet they discharged 1,140 gallons of water per hour. Driven by an engine of the same size a pair of 4-inch pumps which were working on a lift of 33 feet discharged 1,500 gallons per hour. The main advantage claimed for this pump is that it can be worked on a well of considerable depth, and that it can deal with comparatively small quantities of water in a fairly efficient way.

As you are all aware, the wells in Coimbatore are often very deep, and whilst in the hot weather the water level is very

low, it rises nearly to the surface of the ground towards the end of the rains, and it is difficult to conveniently arrange to work with centrifugal pumps. It is necessary that these pumps should be placed above the higher water level and the level of water in the well must not fall to more than about 25 feet below the level of the pump as the pump cannot suck water from a greater depth. If, therefore, the water level fluctuates more than 25 feet, either the pump must be shifted to a higher level during the rainy season, or it must be placed in a water-tight chamber. Either alternative is unsatisfactory, but the difficulties can be got over completely by using drowned centrifugal pumps, which are placed at the bottom of the well; the runner revolves in a horizontal plane and is driven by a vertical shaft which can be carried to the top of the well. The objection to this type of pump is mainly the expense, but it also requires more careful supervision in the running than does the ordinary type of pump which we now employ. The double piston pumps are entirely free from these disadvantages, and in a deep well it is only necessary to use a longer piston to obtain the same degree of efficiency in working as when the lift is small.

A pair of cattle employed on a mhote cannot be expected to work on an average more than six hours a day, but a double piston pump may be run the whole day through, and a pair of 5-in. pumps may be considered equivalent to four mhotes, whilst a pair of 6-in. pumps will easily do as much work as six mhotes. The cost of lifting water by these pumps works out roughly at about one-half the cost when cattle power is employed, and there are in this district nearly 10,000 wells on which such pumps could be advantageously installed. Possibly the number is even larger, but that is a point which I will deal with when I come to discuss the question of how to improve the water-supply from the wells.

Comparative Statistics.

With oil-engines and centrifugal pumps the cost of lifting water decreases per unit as the quantity to be lifted increases, so that the larger the supply of water the greater is the saving in

substituting mechanical methods for those which have hitherto been used. Where the water-supply is large, this is already tolerably well recognised by the ryots, and there is no necessity to refer to it here. The advantages of very small installations, however, are not so apparent, and it seems desirable to show how matters really stand. Let us assume that we have a well which will yield 50,000 gallons of water per day and that the vertical lift is 30 feet. This involves doing useful work to the extent of 15,000,000 foot pounds a day, and the cost of lifting water by cattle will come to about Rs. 3-12-0, five pairs of cattle being required. The same work can be done with a $3\frac{1}{2}$ h. p. engine and a double 6-in. pump in about eight hours. The fuel for the engine will cost annas 12 a day and the other expenses including driver's wages and $12\frac{1}{2}$ per cent. for interest and depreciation will make the total slightly under Rs. 2 a day; that is to say, the cost of irrigation will be reduced by Rs. 1-14-0, equivalent to at least Rs. 375 in a year, allowing for only 200 working days and assuming that the cattle can be usefully employed on other work during the rest of the time. Now, a saving of Rs. 375, capitalised at $6\frac{1}{4}$ per cent. amounts to Rs. 6,000, but the cost of an engine and a pair of these pumps on a 30-feet lift is Rs. 1,535 in Madras, and in most places they could be provided with an engine house and erected at the site of the well for less than Rs. 2,000; that is to say, there is a clear saving in the transaction equivalent to $6\frac{1}{4}$ per cent. on Rs. 4,000 a year. The value of a well is not what it will cost to sink, but depends upon the quantity of water which it will yield, and no matter what it is worth to start with, its value is increased by Rs. 6,000 if the cost of lifting water is reduced from Rs. 3-12-0 to Rs. 1-14-0 per day.

Saving in Working Expenses.

It is possible that some of you may not be prepared to accept my figures, but I think you all admit that the introduction of the engine and pump does effect a considerable saving in working expenses and therefore adds materially to the capital value of the land commanded by the well. As I have already said, there are

probably 10,000 wells in this district which could be profitably equipped with these small engines and pumps, and if we assume that on an average we effect a saving of Rs. 1-14-0 a day for 200 days in the year, the total reduction in working expenses will amount to the very large sum of Rs. 37½ lakhs, or roughly one fourth of Rs. 1½ crores, which is now spent on lifting water in this district. Approximately Rs. 2 crores would be required to instal these engines and pumps, and the return on the capital outlay will be at the rate of 25 per cent. It must be remembered that we have already allowed 6¼ per cent. interest on the capital outlay in calculating the working expenses.

Through the kindness of Mr. J. K Lancashire, the Special Settlement Officer in this district, who takes great interest in the development of well cultivation, I have been supplied with a large amount of information regarding the distribution of wells and the number of water-lifts fitted to them. The statistics, he has supplied me with, relate to 65,547 wells from which water is drawn by 105,311 mhotes: 1,177 of these wells are worked by four mhotes or more and 3,153 wells have three mhotes, whilst in no less than 29,927 wells two mhotes are employed. Probably 10 per cent. may be added to these figures to include the whole district, as Coimbatore Taluk has been omitted. Now it is reasonable to assume that where more than one mhote has been fitted to a well, the supply of water is sufficient to justify the installation of the extra mhotes, but it by no means follows that, in every case, or even in the majority of the cases, the number of mhotes is sufficient to deal with the full capacity of the well. Speaking generally, I may say that where we have installed engines and pumps we usually obtain a much larger water-supply than could possibly have been taken out by the mhotes formerly in use. This is due to the fact that with an engine and pump it is possible to keep the water in a well at a permanently lower level and thereby the inflow has been very much increased. Coimbatore wells, as a rule, are already fairly deep, and in seasons of drought it has been the practice of the ryots to deepen them in the hope of augmenting their supply, so that in normal years

there are many wells which cannot be emptied with the appliances ordinarily at the command of the ryot. The introduction of the engine and pump adds so much to the resources of the ryot for lifting water that I have not yet come across a well in this district which could not be completely emptied in the hot weather. With pumps at his command it becomes a comparatively simple matter to deepen the wells. The water-bearing stratum, upon which these wells are dependent for their supplies, is a thick layer of highly decomposed rock, and to obtain the maximum supply possible, the well should be carried down till its bottom rests on hard rock and from fissures in this hard rock further water-supplies can sometimes be obtained by putting down bore holes and blasting them with dynamite.

The Typical Well.

As you are aware, the typical Coimbatore well is a rectangular hole sunk in the ground. The area of the well is often very considerable and it forms an underground reservoir in which the water can be stored during the night and removed by day. Ryots are prone to enlarge the capacity of their wells rather than deepen them, and quite recently I have seen several very large wells still further extended laterally, when the excavation should have been in a vertical direction. The best way of dealing with the wells is to go on deepening at the point where the water is to be drawn out till the rock becomes so hard that it no longer pays to remove it, and then from this point lateral extension should be made by small adits or tunnels. It is quite useless and, therefore, unnecessary to go to the cost of removing all the superincumbent material. The decayed rock is usually hard enough to render the work of tunneling quite safe and yet not so hard that it cannot be done by the ordinary labour available. Wells are often placed within a short distance of one another, and by connecting them with a short tunnel two wells can be made into one and the whole water-supply withdrawn at a single point, whereby, if an engine and pump can be employed, considerable economy will be effected.

Possibilities of Engine Power.

For the present it is only possible to take such measures as are practicable for the installation of oil-engines as a source of power for driving pumps, sugarcane-crushing mills, rice-hulling machinery and cotton gins; but the distribution of wells, as disclosed by the statements furnished to me by Mr. Lancashire, suggests the possibility that in a by no means remote future the conditions are such that electrical distribution of power in not a few Coimbatore villages is well within the bounds of practical possibilities. Take, for instance, the village of Singanallur. It is situated almost in the centre of a large area of black cotton soil, mainly devoted to the cultivation of cotton. The occupied area includes 3,395 acres of dry cultivation and 929 acres of wet cultivation. The area under sugarcane is 518 acres, and there are 150 supplemental wells for the water-supply to the wet land. The garden crops on the dry land are irrigated by 226 wells fitted with 495 mhotes. Of these wells 15 have four or more mhotes, 35 three mhotes and 154 two mhotes. In the immediate vicinity are the villages of Uppilipalayam and Surapalayam with 158 wells and 83 wells respectively. In these three villages there are, in all, 1,051 water-lifts for dry cultivation and between 400 and 500 employed on supplemental wells. Obviously the amount of power required is very large, and there seems to be a *primâ facie* case for detailed investigation as to the possibility of a central power station distributing electric energy throughout this tract of country. It would be possible to extend the area considerably to the east through the villages situated in the Noyel Valley as far as Tiruppur. Mention may be made of Sulur, Kalangal, Karaivalimaduppur, Samalapuram, Pumalur and Sammandampaliam. In these six villages there are not less than 1,962 water-lifts, 97 wells having four or more mhotes and 221 having three mhotes. These figures added to those already given for the Singanallur group indicate without doubt that there is a considerable field for the installation of an electric supply scheme. Probably it would be best to generate the power in central stations worked by modern oil or gas engines.

preferably the latter, as it would not be difficult to obtain a sufficient supply of wood fuel from the Coimbatore forests. Incidentally it may be remarked that the conversion of wood into charcoal is by no means necessary for the manufacture of suction gas for fairly large installations. At a rough guess I should think that 10,000 h.p. could be readily employed in this tract of country not more than 20 miles in length and some 3 or 4 miles in width. Probably the Power Supply Company would not only have to deliver power to the ryots, but it would have also to provide the electrically driven pumps and other machinery.

I do not want to go into details. The scheme seems to me to be a quite feasible one, but it requires investigating in detail before any definite expression of opinion as to the commercial results likely to be obtained. At no great distance to the north is situated the Nilgiri Plateau: at about the same distance to the south are the Anamalai Hills. It is practically certain that the construction of a few small storage reservoirs on the Nilgiris will enable a sufficient amount of power to be obtained to supply the requirements of this tract of country. The prospects are probably not so good in the Anamalais, but there is undoubtedly a certain amount of water power available there which, however, could probably be better employed in the tract of country lying to the north of the main road between Udumalpet and Dharapuram. There, well irrigation is very extensively developed and the concentration is almost as intense as in the Noyel Valley.

The Coimbatore ryots, in the face of considerable natural difficulties, have displayed no mean amount of skill in making the most of their natural resources. To achieve further progress they must avail themselves of the services of engineers and capitalists. If they continue to display the same energy in the future that they have done in the past, I have no doubt that in a few years' time they will be held up to the rest of India as an example of what can be accomplished when enterprise and energy are forthcoming.

YELLOW FEVER AND MOSQUITOS.

BY

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RECENT events have brought into the field of practical politics the possibility that Yellow Fever may be added to the list of diseases prevalent in India. It is feared that the opening of the Panama Canal, which is planned for next year, may so shorten the route from the fever-zone in the West Indies and Central America as to increase to a dangerous degree the chances that the disease may be introduced into this country: it being assumed that our present immunity from this terrible scourge has been due to the fact that the route hitherto has been long and has passed through northern latitudes.

The probability that the disease, if once introduced, would spread with any rapidity depends very largely on the presence or absence of certain mosquitos, since Yellow Fever, like Malaria, is "carried," from one person to another by these insects.

The organism which causes the fever is so minute that it has not yet been possible to isolate it and study it microscopically, but by allowing mosquitos to bite first a patient suffering from Yellow Fever and subsequently a healthy person, it has been found that the healthy person develops the disease if the mosquito that bit him was the one known as *Stegomyia fasciata*. The obvious inference is that this mosquito is capable of transmitting the disease from one person to another, and this is supported by the fact that it has been found possible practically to eradicate the disease in a given area by closing all places where mosquitos might breed. It is a "domestic" mosquito, and is generally found in or near human dwelling-places, while it breeds in almost

any small casual accumulation of water, such as sardine-tins, broken pots, old boots, the cut ends of bamboos, and so on. Now it is from our point of view in India a matter of the first importance to know whether this *S. fasciata* is the one and only *Stegomyia* capable of carrying the disease, and unfortunately there seems to be no evidence to show whether or no the other species of the genus *Stegomyia* (and there are several others) may be dismissed as harmless, or whether they too must be regarded as potential vehicles of evil. Judging by analogy with the case of *Anopheles* mosquitos and Malaria, it seems most likely that some or all of the other species of *Stegomyia* might be found capable of carrying Yellow Fever, since the apparent differences between the species of *Stegomyia* are no greater than those seen among the malaria-carrying Anophelines.

The reason why this point is of importance is as follows. In our large sea-ports, and particularly in Bombay and Calcutta, *S. fasciata* is a common insect: as I write these lines (in a Bombay hotel) two of them are making determined assaults on my ankles, and in this month of August they are certainly the most troublesome of the Bombay mosquitos. In Calcutta they are also quite common, especially about the suburbs and outskirts of the city. On the other hand, in up-country districts they are by no means abundant, and though widely distributed, it is difficult in most places to find more than a few scattered individuals. In these inland districts it is nearly always the species *S. scutellaris* which is the common representative of the genus: this species is indeed one of the commonest and most annoying mosquitos in India. Both *S. fasciata* and *S. scutellaris* are blackish mosquitos marked with shining silvery spots, but they can easily be distinguished by looking at their backs (*i.e.*, the dorsal surface of the thorax): here *fasciata* has a pattern like a lyre with two strings, two straight lines in the middle and a curved line on each side, whereas *scutellaris* has one conspicuous bright line only, in the middle of the black back.

It is evident from this that if Yellow Fever were introduced into the country, and *S. fasciata* were in truth the only efficient

carrier, we should expect the disease to be more or less confined to the coast districts and sea-port towns, while if *S. scutellaris* also proved to be a carrier there would be no obvious reason why it should not spread infection all over the country. In the latter event it is conceivable that the ravages of plague might be equalled or even surpassed. The distribution of the different species of *Stegomyia* in the larger sea-ports is now being ascertained with accuracy by a number of medical officers specially deputed to carry out a systematic survey, and this investigation has particularly in view the seasonal occurrence and normal breeding-places of *S. fasciata*. The up-country *S. scutellaris* breeds mostly in the cut ends of bamboos filled with rain-water, or in accumulations of water in trees. The choice of breeding places is quite different from that of the malaria-carrying anopheline mosquitos, and another interesting difference exists in the way in which these two groups respectively tide over the cold dry season of the year when conditions are unfavourable and breeding-places (*i.e.*, suitable accumulations of water) are rare or absent. Most mosquitos lie up through these hard times in a hibernating or semi-hibernating condition, and when conditions improve, emerge from their seclusion and resume an active and egg-laying existence. The *Stegomyia* mosquitos, however, do not seem to hibernate, but depend for the continuance of their race on the vitality of their eggs. These eggs are laid in water which at the beginning of the dry weather soon evaporates: the eggs left high and dry do not perish, but live on, it may be for several months, until the coming of rain enables them to hatch. It is not improbable that a proper temperature as well as moisture is necessary for hatching, since eggs laid at Pusa in December did not hatch until March, although they were kept in water the whole time.

The eggs of *S. fasciata* were known to have considerable powers of resisting drought, but the discovery that this is the normal method of tiding over dry weather in the case of all the common Indian species (as our results seem to show) is of rather special interest. It is believed, though the fact is

not yet fully confirmed, that Yellow Fever can be conveyed by the *offspring* of an infected mosquito as well as by the parent itself, and if this is the case, the above facts will have an obvious practical bearing. The method of taking advantage of this peculiarity of habit would seem to be on lines rather different from the usual indiscriminate destruction of larvæ and adults most commonly advocated. It is evident that if we could destroy all the hibernating eggs in the dry weather, we should wipe out the race for the time being. The plan to be adopted should therefore aim at destroying as far as possible the casual natural breeding-places, but at the same time providing artificial breeding places (*e.g.*, cut bamboos holding water) in which the mosquitos may be encouraged to breed. These artificial breeding-places are under complete control and may be emptied out and refilled with water once a week, thus destroying any larvæ that may have hatched in them. Our ideal would be reached if we succeeded in enticing all the mosquitos in the neighbourhood to lay their eggs, at the beginning of the dry weather at the end of the rains, in the artificial breeding-places instead of scattering them about in uncontrollable places, and we should see to it that no eggs were in a position to survive till the next rains. The only doubtful part of such a scheme is of course the difficulty of finding and destroying the natural breeding-places, but in country districts the filling up of cut bamboos and holes in trees will certainly account for a very large proportion of these.

ROOT DEVELOPMENT OF CEREALS.

BY

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Deputy Director of Agriculture, United Provinces.

In a previous article* the teaching of Demtschinsky was briefly outlined and mention was made that experiments along similar lines were being carried on at Aligarh. These experiments have now yielded information of considerable practical importance with regard to maize cultivation.

The ordinary method of sowing maize practised in the Aligarh and neighbouring districts is to drop the seed in the furrow behind the country plough. As the crop grows, the necessary weedings are given and later on the plants are earthed up. Maize, as is well known, is a very shallow-rooted crop and in these Provinces it is one of the first to suffer when water is scarce. On account of its shallow root system it is frequently damaged considerably by winds.

In the previous article the yields obtained in a preliminary experiment comparing deep and shallow sowing of maize were given. By sowing at a greater depth and earthing up when the plants were about 15 inches high a very large increase of grain was obtained as compared with the ordinary method of sowing. The deeper sown crop showed much deeper root development and suffered less from drought than the shallow sown crop. In this experiment the deep sowing was all done by hand. Having obtained these results it was necessary to work out a method of sowing which the ordinary cultivator could carry out cheaply and quickly.

2. Satisfactory results have now been obtained by sowing with the ordinary wheat sowing drill of this locality. The method of sowing wheat here is very different from that in other parts of the United Provinces. A specially built plough is used which goes into the ground much deeper than the ordinary plough. The body of the plough is very narrow and sharp-pointed. This shape lightens the draft and enables narrow furrows to be made. A bamboo tube is attached with its spout in close contact with the heel of the plough. The seed drops into the narrow furrow at the heel of the plough and immediately earth falls back into the furrow and covers the seed to a depth of about $2\frac{1}{2}$ inches. The upper part of the furrow remains open. When the ploughman opens up the next furrow he takes care to avoid filling up the sown furrow. No rolling is done so that after sowing is finished the field has an uneven appearance. This method of sowing has now been tried with maize. Only one alteration or addition has been found necessary. When wheat is sown, the soil surrounding the seed is left rather loose, but as at that time of year the temperature is low and moisture fairly plentiful, the seed germinates satisfactorily: after sowing in the hot weather, the ground must be compressed, otherwise the hot winds dry out the open furrow and sufficient moisture does not reach the seed to start it to germinate. It is a very simple matter to attach something behind the plough which will run along in the furrow and press down the soil which has fallen on the top of the seed. A short round piece of iron answers the purpose satisfactorily. If narrow and attached close up to the plough, it compresses the soil without breaking down the adjoining ridges. By this method of sowing, maize seed can be put into the ground 3 to 4 inches deeper than when dropped into the furrow behind the ordinary country plough.

When the plants are about 15" high, the ridges are levelled off in the ordinary course of weeding the crop. This involves practically no additional labour.

Having worked out a satisfactory way of sowing the crop, a few plots were sown in villages near the Farm. Comparative

yields are not yet available, but already everybody is convinced of the value of this method of sowing. The deeper sown maize germinated more regularly. It grew much more rapidly and was soon a foot higher than that in the neighbouring plots, and at one period when lack of water made the adjoining maize turn yellow, the deeper sown maize retained its dark green colour and continued growing. The fields are a source of great interest to all passers-by and a large number of people have expressed a desire to sow their maize in this way next year. It should be pointed out that in all the above-mentioned cases the crop was sown on irrigation and was well established before the rains commenced. It is too early yet to express an opinion as to the value of the method where maize is sown with the rains. Trials are being carried on to test this.

In the meantime demonstration of the method can go on on the lakh of acres of irrigated maize grown within easy reach of Aligarh.

DRAINAGE AND SOIL AERATION.

BY

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Deputy Director of Agriculture, Cuba Provinces.

DRAINAGE is generally undertaken in order to free land from an excess of more or less stagnant water. In addition it is usually believed to result in continuous and thorough aeration of the soil in the following way.

An ordinary soil always contains a certain amount of air in its surface layers. When rain falls, this air is gradually driven out by the water, and as the water sinks down and is carried away by the drains, more air is drawn into the soil at the surface. Theoretically this would seem to result in efficient aeration in countries where rainfall is at all frequent, but recent observations made by Friedersdorff and his co-workers at Halle have shown that owing to various factors the amount of aeration of a soil drained in the ordinary way is very small.

His experiments lead to the following conclusions (I omit all figures, etc., and give merely the opinions he arrived at as the results of his tests).

As drains have only a single connection with the outer air, *viz.*, the outlet, the amount of air movement in the drain pipes is very small. If the air in the drain pipes were colder than the outer air, it would tend to flow out provided it stood in connection with the atmospheric air above the drain. But this connection is practically non-existent because the capillary tubes from the drains to the surface of the soil contain so much water that the passage of air down these tubes to the drain is almost entirely prevented. Air cannot ordinarily reach the drain from above and therefore the cold air in the drain cannot flow out.

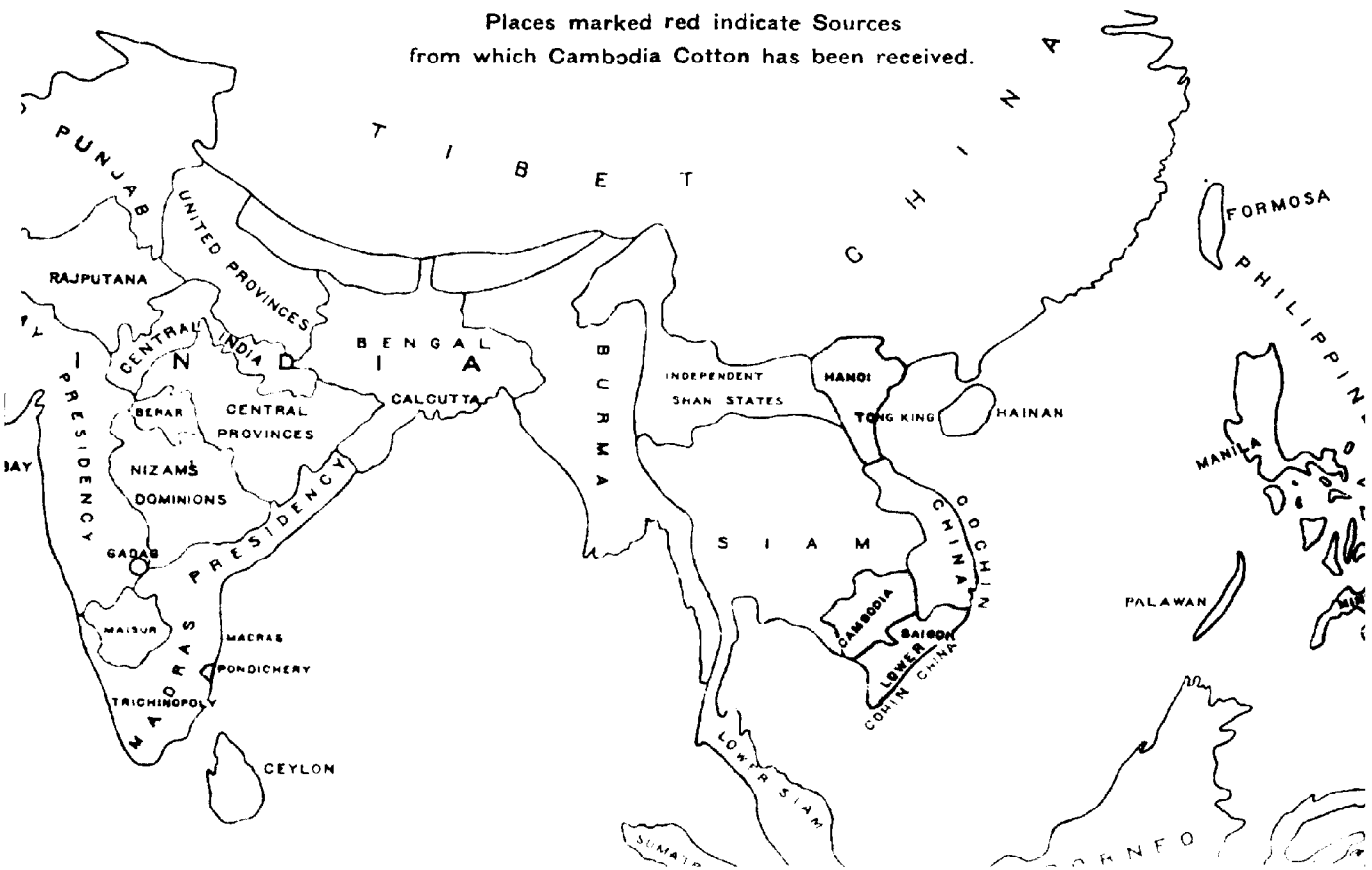
There is thus very little air movement either in the drains themselves or in the soil. New air is sucked in only as often as sufficient rain falls. Since there is very little circulation of air, the air which is in the soil often contains such a large percentage of oxidation products that it is either inactive or harmful from the point of view of the plant.

In order, therefore, to obtain more thorough aeration, Friedersdorff laid down drains with the usual opening at the outlet end of the main drain and, by means of tubes, connected the side drains with the air at the place of their commencement. His observations show that, in drainage systems laid down in this way, there is an almost continuous stream of air through the drain pipes. At the same time some of this stream is deflected from its ordinary channel, passes into the cracks and openings in the soil, pushes aside the water in the capillary tubes, and rises to the surface of the ground. By this means the soil is thoroughly aerated.

A test of the method was carried on in the field. A drained area was divided into two parts. In one plot the drains were connected with the air in several places. In the other they were left unconnected. The former plot yielded a decidedly better crop. One of Friedersdorff's co-workers discusses the questions from the bacteriological standpoint. He points out the possibility of this method of soil aeration rendering the whole of the layer of soil from the surface down to the drain pipes available for the growth of those valuable Nitrogen collecting organisms the Azotobacter.

It has frequently been observed that the nodules of the Leguminosæ, in which Bacillus radicicola does its useful work, are borne only in the upper layers of the soil. Thorough aeration to a greater depth may make a much larger root area available for the growth of these bacteria.

The method above outlined seems to have an immediate practical value in draining swampy places where rapid sweetening of the soil is desired. It also opens up many lines for thought and possible investigation as to its value in ordinary soil.


Places marked red indicate Sources
from which Cambodia Cotton has been received.
PUNJAB
UNITED PROVINCES
RAJPUTANA
CENTRAL INDIA
BENGAL
I N D I A
CALCUTTA
BERAR
CENTRAL PROVINCES
NIZAMS DOMINIONS
BOMBAY PRESIDENCY
MADRAS PRESIDENCY
GADAG
MAISUR
MADRAS
PONDICHERY
TRICHINOPOLY
CEYLON
BURMA
TIBET
CHINA
INDEPENDENT SHAN STATES
HANOI
TONG KING
HAINAN
FORMOSA
PHILIPPINES
MANILA
PALAWAN
SIAM
COCHIN CHINA
CAMBODIA
SAIGON
LOWER COCHIN CHINA
LOWER SIAM
SUMATRA
BORNEO

CAMBODIA COTTON IN BOMBAY PRESIDENCY.

BY

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INTRODUCTION.

In the October (1911) number of this Journal, Mr. Sampson published an interesting account of the introduction and spread of Cambodia cotton in the Madras Presidency. In that article he showed how the seed of this cotton had been introduced from Pondicherry through two independent channels in 1904 by Mr. Benson, and in 1905 by Mr. Steel.

About the same time (December 1904) the existence of this cotton came to the notice of Mr. Fletcher, late Deputy Director of Agriculture in Bombay Presidency, when perusing the Annual Report of the British Vice-Consul of Saigon in Cochin China, through whom he was successful in obtaining seed from Hanoi in January 1906 from the Agricultural Department of Tongking (French possession), whither it had been introduced many years previously from Cambodia in Indo-China; but previous to this a sample of seed of what turned out to be identical with Cambodia cotton, was received from the Philippine Islands in the spring of 1905. Later on seed was obtained in March 1906 from Mr. A. V. Authmanatha Aiyer of Anukkur, Perambalur, Trichinopoly District, Madras, and subsequently seed of this same cotton has been received from various sources.

EARLY TRIALS.

Experimental trials were commenced in 1905 on the Surat Farm in Gujerat, but the local conditions—a heavy black cotton

soil and a rainfall of 36·33 inches—did not appear to suit this cotton which was then transferred to Dharwar in the south of the Presidency. Here promising results were obtained for a year or two, but not sufficiently so to warrant the distribution of seed to the public, and in fact as time went on, it appeared to be deteriorating as regards prolificness and also as regards resistance to "red leaf blight" which attacks all exotic cottons grown at Dharwar, and comparative experiments indicated that this cotton could not compete with either local Kumpta or introduced Navsari (Broach) when grown as a non-irrigated crop on the heavier types of black cotton soil as represented by the land on which the Government Farm is situated.

Establishment of a Special Farm at Gadag.

It was thought, however, that greater success might be met with if trials were conducted in the tract where Dharwar American cotton, introduced nearly a century ago, had acclimatized itself. This comprises parts of the Talukas of Ron, Gadag, Bankapur Karajgi, Ranibennur and Kod in the south-east of the Dharwar District, where two types of soil are met with: (1) medium black and (2) red. Dharwar American cotton is cultivated as a non-irrigated crop on both of these classes of soil, but in the former case it is grown in the *rabi* season, being sown about the middle of September, while in the latter it is sown at the beginning of the monsoon. No separate returns are given for Dharwar American and other cottons, but it has roughly been computed that the area annually sown with this variety in the Dharwar District is about 200,000 acres, but in addition to this it is grown at Barsi and in adjacent areas of Hyderabad and Madras Presidency.

Accordingly a piece of land consisting of medium black soil was taken up at Gadag, an important cotton market, and a farm established in 1908-09 with the primary object of testing the suitability of newly introduced American and Cambodia cottons and for comparing these with Dharwar American in the tract of country where the latter had become acclimatized.

Results of the Experiments conducted at Gadag.

Suitability for cultivation in the Dharwar American Tract :— The first point which required investigation was the suitability or adaptability of this cotton to local conditions. Experimental cultivation both on the farm and in cultivators' fields during the last three years has proved that this cotton is well adapted for cultivation at Gadag as may be inferred from the results obtained in comparative experiments with local saw-ginned Dharwar American cotton herewith tabulated :—

	Yield per acre of seed cotton in lbs.		Ginning percentage.		Remarks.
	Cambodia.	Saw-ginned Dharwar American.	Cambodia.	Saw-ginned Dharwar American.	
1909-10	420	384	42·80	36·87	
1910-11	413·5	221	38·31	30·70	A moderate season.
1911-12	197	104	28·05	28·30	A very bad season.

The importance of these results lies not only in the relatively heavier yields and higher ginning percentages of this cotton, but also in the proof which they provide that Cambodia cotton is a drought-resisting variety of exceptional capacity. The most striking instance of this was offered in the season of 1911-12 which was characterized by the worst drought experienced for many years. The total rainfall up to the end of August was 10·13 inches. During September only $\frac{3}{4}$th of an inch fell which was insufficient to permit of sowing operations at the normal time, which had to be delayed for nearly a month until after a fall of rain amounting to one inch on the 10th October. After this there were only 2·5 cents of rain until the 1st December when there was an unexpected shower amounting to half an inch. The total rainfall for the season thus amounted to only 15·77 inches of which only 80 cents fell after the crop was sown—against an average of 23·43 inches. Nevertheless in a comparative

experiment conducted on a large[1] scale the results noted above were obtained. These results are interesting when compared with the conclusion arrived at by Mr. Sampson in the article referred to above when discussing the root system of Cambodia cotton. He states "and it can also be understood why this crop if grown on black cotton soil with the aid of rain alone, cannot resist prolonged drought."

The next point which had to be cleared up was, which of the various Cambodias was the best. Comparative experiments leave little doubt on this point for No. 102-E., received originally from Mr. Aiyer of Trichinopoly, has annually proved its superiority over all others both as regards yielding capacity and ginning percentage.

Having shown the suitability of Cambodia cotton for cultivation in the south-east of the Dharwar District it may be convenient to summarise here its advantages which have been found over local saw-ginned Dharwar American. These are—

(1) A higher ginning percentage of at least 7 per cent. The ginning percentage of saw-ginned Dharwar is normally about 30 per cent., while a very moderate sample of (102-E) Cambodia gins at 37 per cent. and good samples gin from 1 to 2 points higher. The highest ginning percentage attained by this cotton on the Gadag Farm was 42·8 in 1909-10.

(2) A higher yield in the proportion of at least 9 to 8.

(3) The seed cotton being produced in large well-opening bolls can be picked cleaner.

(4) The colour of the cotton is brighter and the staple more uniform.

(5) The cotton is 'bulkier.'

(6) It is markedly resistant to red leaf blight which so severely attacks saw-ginned Dharwar.

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[1] The areas of the Cambodia and Dharwar American plots were 1·8 and 0·9 acres respectively.

Opinions of Cultivators.

The Gadag Farm is situated adjoining the public road which connects Gadag with Hubli, and from the very beginning the fine appearance of Cambodia cotton with its prolific plants and their huge bolls giving forth snowwhite kapas, has proved a great attraction to passers-by, and many applications for seed have been received without further enquiry. No attempt, however, to force this cotton upon the public was made during the period when it was under experimental investigation. In 1909-10 only 100 lbs. of seed was given out among 14 cultivators all of whom reported satisfactory results. In 1910-11 a couple of thousand pounds were distributed among 34 cultivators, while in 1911-12, 5,000 lbs. were distributed and more would eagerly have been taken up had it been available because the price offered for this cotton* in the Gadag Market for the produce of the 1909-10 crop was Rs. 180 against Rs. 123-8 per naga of 1,344 lbs. of seed cotton for saw-ginned Dharwar American. In the current season (1912-13) arrangements have been made to distribute 30,000 lbs. of seed estimated to sow 3,000 acres.

An Auction Sale.

In 1911-12 the crop raised was on a sufficiently large scale to attract the attention of the trade, and Messrs. Tata and Sons in particular suggested that the Agricultural Department should organize an auction sale for this cotton on the same lines as had been done for some years at Dharwar for Navasari (Broach) cotton. This suggestion was all the more appropriate because the local merchants were only offering some Rs. 20 per naga (1,344 lbs.) more for this cotton than for local saw-ginned Dharwar American. Accordingly the Department decided to act upon Messrs. Tata and Sons' suggestion and the auction

* A large sample of the 1909-10 crop amounting to one full pressed bale (400 lbs.) was sent to Liverpool and was very favourably reported upon. Messrs. Hoyle and Jackson, Ltd., of Oldham, valued this cotton at 7¾*d.* with middling American quoted at 7·88*d.* Another firm reported "very clean, almost as good as good Middling American, perhaps equal to stable

took place on the 14th April, 1912, in the presence of a good company of merchants from Gadag and Hubli representative both of the local trade and of the wider market in Ahmedabad and Bombay. Altogether 46 nagas (1,344 lbs.) of seed cotton and 43 nagas (336 lbs.) of cotton were put up for sale and realized excellent prices as may be gathered from the following statement :

Grade.	Total No. of Dokras.	Total weight of Kapas. Nagas (1,344 lbs.)	Mannd (24 lbs.)	Seer.	Ginning percent age.	Total weight of Cotton per Naga (1,344 lbs.) of Kapas.	Price per Naga in Rs.	Name of Purchaser.
I	37	17	0		25·26	681	2·6	Representative of Sir Chimanbhai Madhavlal of Ahmedabad.
II	90	16	2	1	24·35	644·3	2·0	Representative of Messrs. Tata and Sons, Bombay.
III	20	10	0	2	33·34	642	2·5	Mr. Naginganda Patil of Hulkoti (Gadag).
IV	31	15	2	3	32·33	656·5	1·8	Mr. Manik Pitambar of Hubli.
	80	43 (cotton)	10				1·20	Messrs. Tata and Sons, Bombay.

Note I.—Messrs. Palumji, cotton merchants, Gadag, gave the local quotations for saw ginned Dharwar on the day of the auction as follows :—Seed cotton—Rs. 140 per naga (1,334 lbs.) Cotton—Rs. 108 per naga (336 lbs.)

Note II.—The Department graded all the seed cotton according to ginning percentage preparatory to the auction and the results were communicated to the public.

Note III.—It will be noticed that grade III sold for a higher price than grade II which was due to the keen demand for this cotton.

These results indicate that when saw-ginned Dharwar is worth Rs. 140 per naga Cambodia is worth Rs. 200 or 43 per cent. more.

Spinning Trials.

It will have been noted in the remark column above that Messrs. Tata and Sons were large buyers at the auction sale. That firm, who also bought largely in Madras, have kindly supplied details of comparative spinning tests which they have had conducted with Cambodia cotton produced at Gadag and in Madras Presidency, where the area cultivated with this cotton has recently greatly expanded. These tests are summarized in the following statement.

Results of trials taken to spin 20's (counts) from Cambodia cotton produced at different places.

Item.	Source of Production.	
	Gadag.	Madras Presidency.
Tension	57·85 lbs.	57·28 lbs.
Turns per inch of spinning wheel	19·64 lbs.	19·64 lbs.
Blow room loss	7·5	9·87
Price per Boja of 345 lbs.	Rs. 141	134-6-0
Nett Price per pound	As. 7-0·63	6-10·16

In commenting upon these trials Messrs. Tata and Sons point out that while Cambodia grown at Gadag showed only 7·5 per cent. of blow room loss, the consignment purchased in Madras gave a loss of 9·87 per cent., and further that the staple of both lots was equally long and strong, but that the Gadag sample appeared to be slightly more "neppy"* than the Madras one which might be due to the different methods of ginning employed. The fact that the length of the staple is equal to that of Cambodia grown in Madras is of great interest as the conditions under which this cotton is cultivated in that Presidency, *viz.*, light soils and irrigation from wells naturally lend themselves to the production of good staple, whereas at Gadag this crop has to be grown as a *rabi* crop† (*i.e.*, receives no rain during the growing period) on medium black soil and without irrigation. Another very important point is the fact that the fibre is found to be strong because in a season of drought like the one under report it has been noticed that the fibre of newly introduced cottons has a tendency to become brittle.

(*Note.*—Recent information shows that Madras Cambodia has deteriorated due to extended and careless cultivation and keeping the plant a second year in the ground.—Ed.)

* Neppy refers to the presence of small matters of fibre matted together into knot-like masses.

† The cotton crop is sown about the middle of September at Gadag and there is seldom more than an inch or two of rain afterwards.

Financial Considerations.

A moderate crop of Saw-ginned Dharwar American cotton in a poorish season is 275 lbs. of seed cotton per acre worth Rs. 24-9-0 if we take the rate at Rs. 120 per naga (1,344 lbs.); and if we assume that Cambodia would yield not less than Saw-ginned Dharwar and that it would command a price of Rs. 175* per naga (1,344 lbs.) then the value of the crop would be Rs. 35-13-0 per acre. Now after deducting Rs. 14 as the cost per acre of production for both cottons, we see that the nett profits would amount to Rs. 10-9-0 and Rs. 21-13-0 for Saw-ginned and Cambodia cottons respectively, or Rs. 11-4-0 per acre in favour of Cambodia. But in paras. 5 and 6 above we indicated that if the best seed of 102-E. Cambodia is used, then the crop may reasonably be expected to yield a heavier outturn than Saw-ginned Dharwar in the proportion of 9 to 8. If then we take this heavier yield -say 310 lbs.-- into consideration, we see that the increased nett profit per acre from the cultivation of Cambodia cotton would amount to Rs. 15-13-0, say Rs. 16 per acre. Now we know that the area annually sown with Saw-ginned Dharwar American cotton in the south-east of the Dharwar District is roughly 200,000 acres, and hence if the whole of this cotton were replaced by Cambodia, the increase in wealth to the district would be enormous.

Plans for the Future.

From the foregoing remarks it will be seen that the Department has an important piece of work to cope with in the south-east of the Dharwar District. First of all, the standard of quality of Cambodia cotton has to be maintained. Selection must be carefully persevered with so as to prevent any falling-off in prolificness or in ginning percentage -both of which phenomena seem quite probable if preventive steps are not taken.

* These rates are low in comparison with those obtained at the auction sale, but at that time cotton quotations were ruling high.

Secondly, this selected seed will have to be multiplied on a large scale and constantly replenished. Thirdly, the greatest efforts will have to be made to prevent the cultivators either intentionally or unintentionally allowing this cotton to become mixed with Saw-ginned Dharwar, which would at once cause a fall in market rates and thereby remove one of the chief incentives to cultivation. Fourthly, a careful watch will have to be kept upon the attitude of the trade so as to secure to the cultivators the true value of their produce, and it seems quite probable that for this purpose auction sales will have to be organized either departmentally or through the medium of some other organization.

A PORTABLE SPRAYING APPARATUS FOR TICKS AND PARASITES ON CATTLE AND A PORTABLE BATH FOR FOOT-AND-MOUTH DISEASE

BY

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I.—PORTABLE SPRAYING APPARATUS.

THE universal presence of ticks and other skin parasites upon animals induced me to inaugurate some means of destroying them not only for the mechanical inconvenience they cause but with the object of stopping or at least mitigating the disease for which many of these parasites are the carriers, or intermediary hosts.

The ideal method would, of course, be dipping baths, but the expense of inauguration and maintenance is at present not practical and so a portable spraying apparatus has been introduced.

This consists of an ordinary garden spraying hose, *viz.*, a suction force pump, as used for the destruction of parasites on crops and other plants. There is a ball valve to prevent regurgitation of the fluid. The suction end of the force pump has a rubber tube which is placed in a bucket of the fluid used. There is an iron stirrup attachment outside the bucket, so that the operator may use both hands to the piston of the pump and press down with one foot. A long rubber tube is fixed to the ejector end of the pump and to the end of the tube a flat rose sprayer in which are 10–12 large holes and the surface of which is concave so that the spray jets are concentrated when thrown upon the body surface of the animal. Spraying is effected by standing to the rear of the animal, the fluid by this means being forced *against the fall* of the hair and coming into direct contact with the skin.

The fluid used for ticks, scabies, ringworm, fleas, lice, etc., is Coopers' Arsenical Dip, mixed according to the directions on the packet. To obviate the danger of arsenic lying about and also to prevent waste, animals are placed upon a tray. As arsenic has no chemical action upon zinc and corrugated zinc sheets

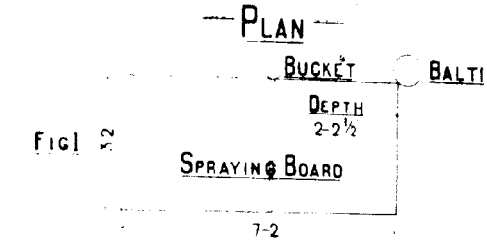


FIG 1

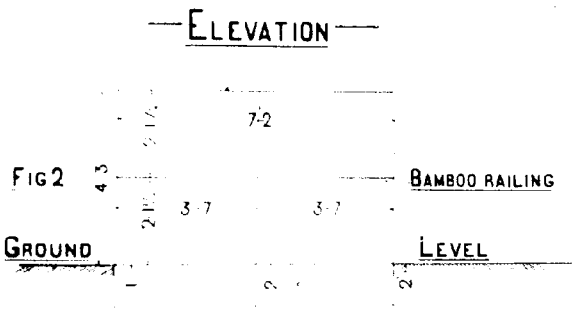


FIG 2

are cheap and light, the tray is made of these. It is in two pieces joined in the centre as per sketch in Fig. 1, by which measurements and size will be seen. These two pieces slope to the centre and are connected by a fold of zinc underneath which acts as a drain. This drain slopes to one side and is so placed as to drain into a bucket. The bucket is let into the ground by digging a hole. By this means all the fluid as it drips off the animal finds its way into the bucket and can be used again, or if not wanted, poured into the hole from which the bucket is taken and buried.

As animals may try to step off the zinc platform, a bamboo fence is fixed (*vide* Fig. 2). This is simply a temporary

arrangement as ordinary bamboos are available in every village in the Central Provinces. Three upright poles each side of the tray are let into the ground and joined together by cross rails. The dimensions are given in the sketch, but exact measurements are immaterial.

Animals usually walk on to the tray without any trouble, but if they are nervous of the sound made by stepping on the zinc, a little grass may be spread over it. The grass is afterwards burnt, taking care that no one stands to leeward of the smoke on account of the arsenical fumes.

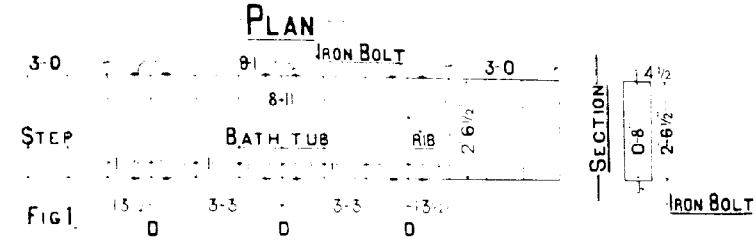
The whole apparatus is very light and can easily be carried upon the ordinary bullock cart. It is very portable and any one can fix it together and dig the hole for the bucket. The Veterinary Assistant can take it with him from village to village and spray a great many animals in a very short time. The application is so simple that danger is reduced to a minimum if the directions are adhered to. After spraying, the animal should stand upon the tray until the fluid ceases to drip and then be kept standing for half an hour or so upon some open place where no animals ever graze: it will then be dry and needs no further attention. The operation should be done in the early morning or evening, so that the sun does not dry them too quickly. I find that Veterinary Assistants have a tendency to divert their attention from the matter in hand and by turning round to talk to admiring bystanders use the sprayer as a dust layer. Such tendencies should be checked as far as possible, as it is undesirable that arsenic should be scattered about anywhere except upon the place in which it is wanted. The method of operation is shown in Plate XLIX.

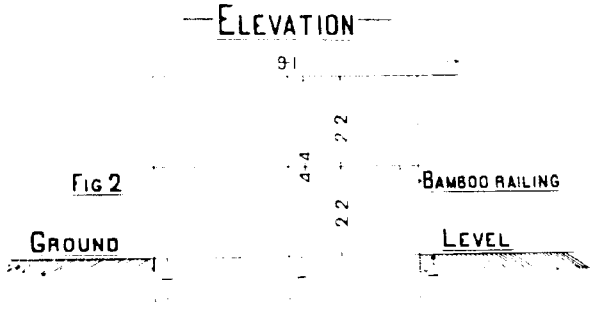
II.—Portable Bath for Foot-and-Mouth Disease.

The dressing by hand of animals affected with the foot lesions of Foot-and-Mouth disease is very tedious and owing to the restiveness of the animals very often improperly done; for this reason a bath has been used in the Central Provinces through which animals may walk or in which they may be kept

standing, thereby thoroughly cleaning and disinfecting the lesions.

It is made much upon the same lines as that devised by Mr. Oliver. The dimensions are given below in the sketch, Fig. 1.





An ordinary wooden trough is used with straight sides 8 inches high and a flat floor across which bars are placed to prevent slipping, the whole being well pitched. The fluid used is Sulphate of Copper solution. The bath is somewhat unwieldy and heavy as it is of wood but it is easily carried upon a bullock cart. In order to prevent animals stepping over the side, bamboo rails are fixed as in the spraying tray, but iron Ds. are fixed into the side of the bath *inside* (Plan DDD) through which the bamboos are placed. They are joined with rails and tied with rope. If necessary a ramp to walk into the bath can be made by packing some earth as shown in Plate L. I.

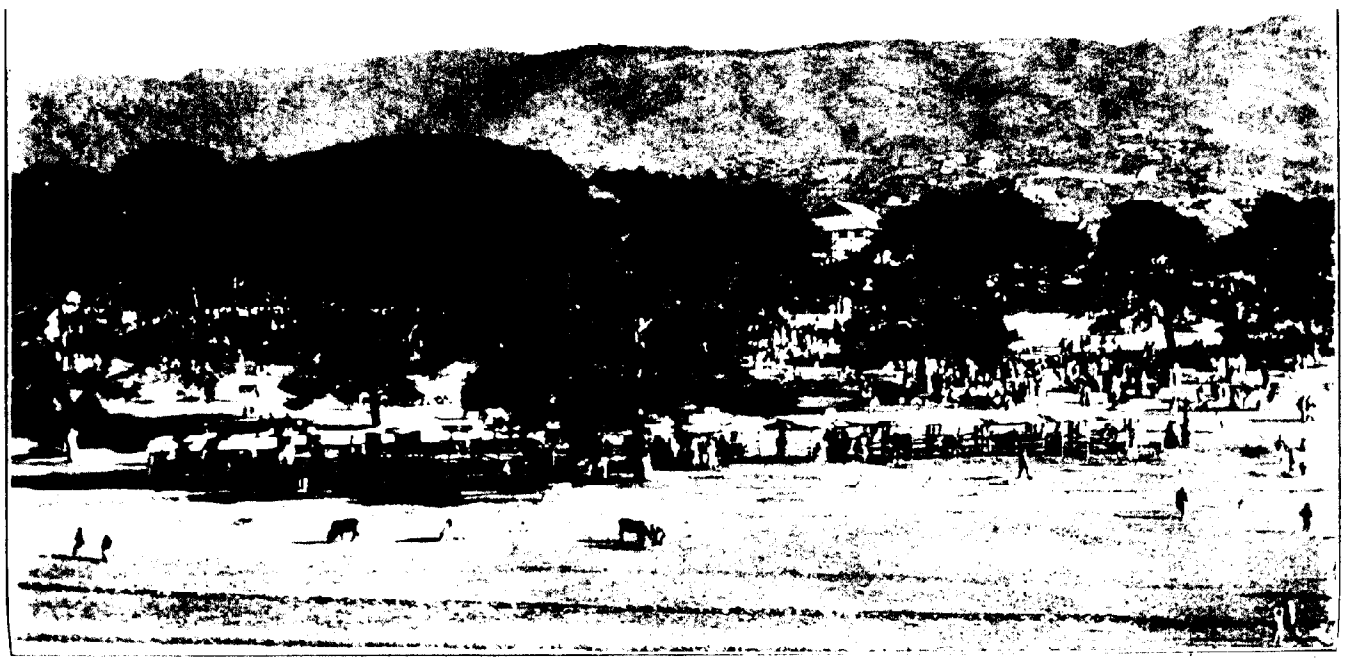
See also Bulletin No. 20, Notes on Foot and Mouth Disease of Cattle in United Provinces.

have found no difficulty in making animals walk through it and by its means a large number of animals affected with the ulcers of Foot-and-Mouth disease can have their feet thoroughly dressed in a very short time and moreover the dressing is very thorough.

As bamboos are so easily obtainable, it is unnecessary for the Veterinary Assistant to burden himself with them when travelling from village to village with either the bath or the spraying apparatus.

Trials of a lighter and more portable bath of zinc sheets were made, but owing to the chemical action of the copper upon the zinc it was found to be impracticable. This is regrettable as the saving in weight was very considerable.

I am much indebted to Mr. Cove of the Technical School, Nagpur, for carrying out the making of the various appliances and the trouble he has had in making and remaking many models.



THE SHILLONG SHOW.

BY

A. G. BIRT, B.Sc.,

Deputy Director of Agriculture, Assam.

A show of flowers, field and garden produce, cattle, dairy produce and poultry is usually held at Shillong in May annually the date this year being May 24th.

The show was held on the slope of a hill in front of the Pine Mount European School, a picturesque site with the Upper Shillong ridge rising almost immediately behind it.

The local Agricultural Department make all the arrangements, the prize money and all expenses being paid from a special grant for the purpose.

A function of this kind is extremely popular with the hill people who come in large crowds from the surrounding country, some walking more than 30 miles in order to be present. Any one acquainted only with the plains people would be struck by the large number of women and girls present, in fact, they usually outnumber the men. The Khasis are a pleasant and cheerful race, and being unburdened with caste and purdah systems, they mix freely together and both sexes lay themselves out to enjoy the day's entertainment.

As the majority of exhibitors are illiterate, any system of entries prior to the show day is impossible: consequently all exhibits are entered as they are brought in. From an early hour on the show day there is a constant stream of exhibitors, each bringing their own produce, and the clerks in charge of the various sections have a very busy time classifying and arranging the exhibits.

Although the prize list printed in Khasi is distributed widely some time before the show, some of the people have very vague ideas as to what is required for exhibition, and some very queer exhibits in the shape of insects, birds, etc., are occasionally brought in.

The judging of the exhibits is undertaken by experienced residents of Shillong, and that the office of judge is no sinecure may be gathered from the fact that this year there were no less than 377 separate exhibits in three classes of potatoes.

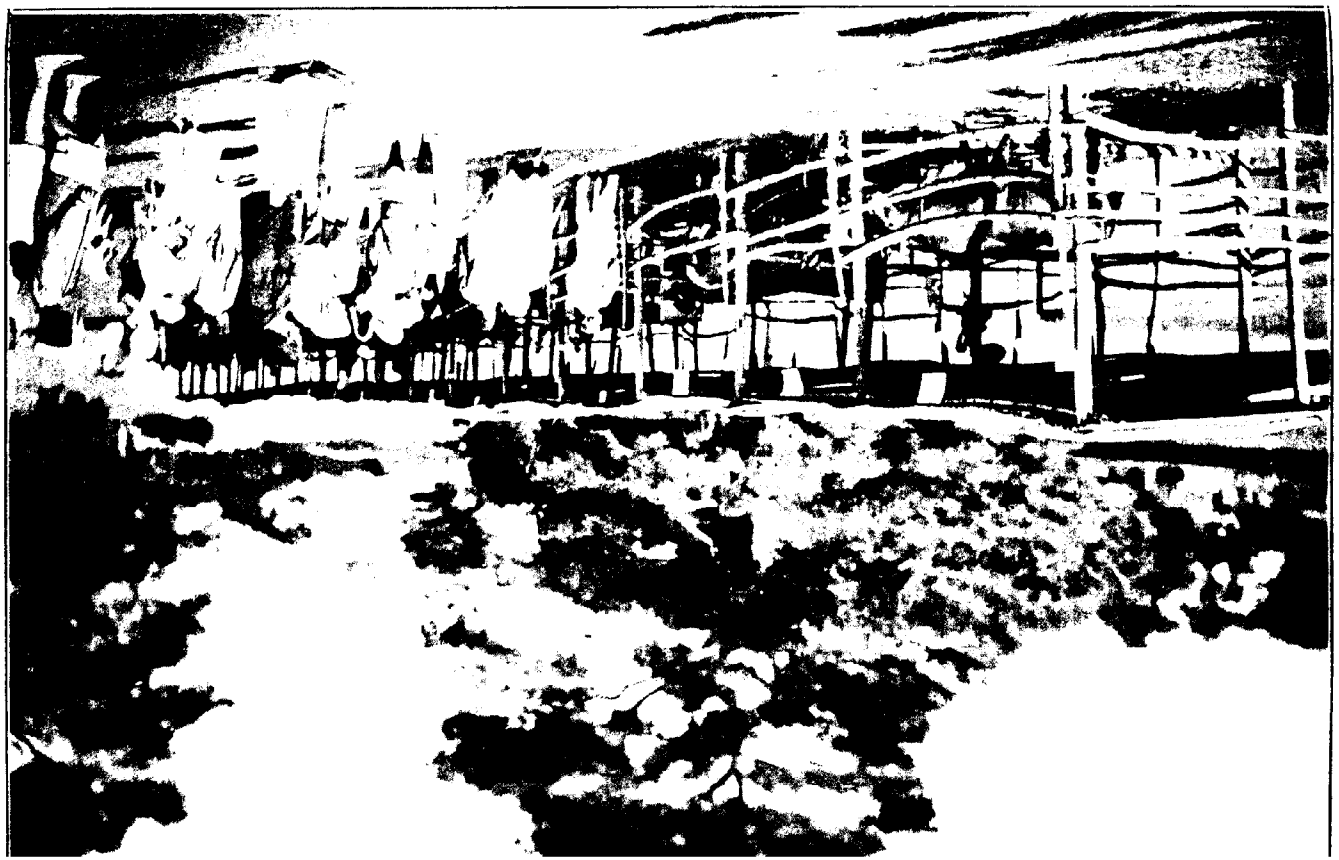
In several sections additional classes are reserved for Khasis only, while the majority of the classes are open to all.

This year the exhibits were not quite up to the usual standard, owing partly to unfavourable weather and partly to the fact that the notice of the show was sent out rather later than usual: this was specially noticeable in the flower sections.

The chief feature of the show was undoubtedly the potatoes which are the staple crop of the Khasi hills. Amongst the 377 exhibits were many excellent specimens of superior varieties introduced by the Agricultural Department. There were also some very fine exhibits of paddy and soy beans grown in the hills. Some of the vegetables were excellent, especially cabbages, cauliflowers, peas, beans and vegetable marrows.

The fruit shown by Khasis, on the whole, was rather disappointing, but there were some good exhibits of plantains, papayas and pineapples. There was one magnificent dish of English strawberries exhibited by a European resident of the town.

There was nothing striking in the section for live stock, the cattle shown comparing very unfavourably with some exhibits (not for competition) from the Government Farm at Upper Shillong. The poultry, however, were, on the whole, very good, the entries numbering nearly 100. The fowls which took prizes were excellent specimens, while the majority of the exhibits showed evidence of English blood. There were also some good exhibits in the classes for ducks and pigeons.



The classes for dairy produce were not well filled, there being only one exhibit of butter and four of cheese. There were 48 entries of fowls' eggs, amongst which were some very fine specimens laid by English fowls.

As in former years, exhibits not for competition were brought from the Upper Shillong Government Farm. The most important of these were the cattle, which included a very fine Patna Khasi crossbred bull and a pure Patna cow bred at the Farm. A Dumba ram and some young crossbred Dumba Khasi sheep were also exhibited. Both cattle and sheep attracted a good deal of attention as being very much superior to the local breeds.

It should be mentioned here that the local Agricultural Department is working on the improvement of the local breeds of cattle and sheep by means of crossing with Patna bulls and Dumba rams respectively.

Several demonstrations were made on the show ground for the benefit of the Khasi cultivators. These included the preparation of Bordeaux Mixture and the working of a spraying machine for spraying potatoes as a preventive of disease. The use of several improved implements likely to be of use locally was also demonstrated.

These demonstrations were attended by a large number of cultivators and advantage was taken of this opportunity to distribute leaflets in their own language dealing with local agricultural improvements.

The attendance at the show was good and included a fair number of Europeans and plains people. The Hon'ble the Chief Commissioner of Assam and Lady Earle visited the show during the afternoon and Lady Earle kindly undertook to distribute the prizes.

The band and pipes of the Gurkha regiment which played during the afternoon were a great attraction to the crowds of visitors.

NOTES.

COSTS OF PRODUCTION IN AGRICULTURE.—The March (1912) number of the Journal of the Board of Agriculture, London, has a note on this subject. It is stated that one of the objects to which the grant for agricultural research, recently placed at the disposal of the Board of Agriculture and Fisheries will be devoted, is the maintenance of an Institute for the study of the Economics of Agriculture. A marked feature of the progress in recent years in the technique of business management has been the prominence given to what are technically known as "Costs." The majority of large manufacturing concerns have now-a-days a costs department, one of whose functions it is to ascertain and record the cost of each operation that is required to convert the raw material into the finished article ready for the market. It enables them to institute comparisons and so check waste, to drop unprofitable lines and develop profitable departments. The need for accurate information on the cost of agricultural operations becomes obvious when we see that it helps us to determine what description of farming pays best under defined conditions, and what the economic condition of a farmer is likely to be in those circumstances. A beginning in this kind of work in relation to agriculture has been made in the United States by the Bureau of Statistics and some interesting papers on the subject have been published.

The method adopted by the United States Bureau of Statistics is to place qualified persons on the farms to keep or obtain records of the times spent on each description of agricultural work, the exact weight and as far as possible, cost of all materials produced or consumed on the farm. The particulars so obtained are carefully abstracted and tabulated and precise information as

to costs is obtained. It is necessary, however, to point out that the issues appear to be simpler in the States in so far as agriculture there seems more specialised and consequently less complex from a book-keeping point of view. A farmer who confines himself to producing wheat or cotton has a much simpler problem of costs to solve than one who takes up mixed farming combined with stock breeding. (EDITOR.)

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ITALIAN RYE GRASS IN PESHAWAR.—During the past two years numerous enquiries regarding grass suitable for feeding green or as hay to horses have been received by the writer from officers in charge of grass farms in the N.-W. F. Province, and the following qualities have invariably been mentioned as being particularly desirable:

(1) Horses or mules must eat the green grass or the dry hay readily.

(2) There should be little or no admixture of inedible grasses; there must be little waste.

(3) The grass must annually yield one or more green cuttings and one heavy cutting of hay which will remain sweet in the stacks.

(4) The cultivation of the grass must be simple.

(5) The hay crop must be cut by a mower.

The last is not the least important of the qualities desired as indigenous grass of good quality cannot be economically cut by the mower, and it is annually becoming more expensive, and more difficult to cut grass by the *khurpa*. During *kharif* (autumn), many fodders were examined and several kinds were tried at the Agricultural Station, Peshawar, but no summer season grass met all the requirements. Some were too coarse for horses; others were difficult to cut, and many were unsuitable for curing to hay. For *rabi* (cold season) trial, Sutton's Giant Italian Rye Grass was imported from England, and half an acre of land was sown in early December. Plate LIV, the photo of which was

taken when the crop was about to be cut, shows how luxuriantly the grass grew on light sandy loam, without any manure, and with but four turns of very sparing irrigation. The previous crop was nursery stock, and this was followed a by fallow between April and December. As the hay was permitted to ripen for seed, the crop was not weighed, but it was fully equal to what would be considered a big crop in Scotland. If sown in September or October on moderately cultivated land, there is reason to expect that one full cutting of green grass and a heavy crop of the best hay can be secured between October and mid-April. On grass farm land, where manure is abundant and water is generally sufficient even two heavy green cuttings might be taken. The following figures indicate the temperature of Peshawar during the months rye grass occupies the land :

Month	[illegible]		[illegible]		[illegible]	
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
November	[illegible]	[illegible]	[illegible]	[illegible]	64	[illegible]
December	[illegible]	[illegible]	[illegible]	24	[illegible]	[illegible]
January	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
February	[illegible]	7	68	[illegible]	44	[illegible]
March	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
April	34	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
May	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
June	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

At the present time (summer) when the maximum temperature has been daily ranging between 113° and 114° in the shade, rye grass stubble is green and promises to withstand the hot weather. If it does so, Perennial Rye Grass might be hopefully tried. Lolium temulentum (Darnel), a species of rye grass, is commonly found in wheat fields in the North West Frontier Province, and I believe also in the Punjab, but this is, of course, a noxious weed. (W. ROBERTSON BROWN.)

TOXIC EFFECTS OF "ALKALI SALTS" IN SOILS ON SOIL BACTERIA. Two important papers by C. B. Lipman have recently appeared in the Centr. Bakt. Par., 1912, ii, 33, 305-313, on the toxic effects of "alkali salts" in soils on soil bacteria and are referred to in the Journal of the Chemical Society for May, 1912 (ii, 473). The first of the papers deals with the effect of sodium chloride, sodium sulphate and sodium carbonate in the quantities occurring in alkali soils, on ammonification. Sodium carbonate is found to stimulate the formation of ammonia.

The second paper shews that nitrification is hindered more by sodium carbonate than by the other two salts. The amounts of these salts sufficient to inhibit the formation of nitrates are sulphate 0·3%, chloride 0·1% and carbonate 0·025% of the weight of dry soil. Thus nitrifying bacteria are greatly hindered in their work by sodium carbonate, whereas the ammonifying bacteria are stimulated.

These conclusions are especially important to us in India and may offer an explanation of the fact that rice can grow in the presence of larger amounts of alkali than most other crops, for it is well known that rice receives its nitrogen in the form of ammonia and does not thrive on nitrates.—(H. E. ANNETT.)

* * *

ENGLISH OATS IN PESHAWAR.—In the cold season of 1910-11 a striking example of the truth that is in much of the folk-lore of the zamindar was afforded at the Peshawar Agricultural Station. It was maintained by cultivators in the neighbourhood that gram would not do well in the greater part of the Peshawar district. No one appeared to know why the crop would not succeed and none of those questioned had tried to grow gram. It was necessary, however, to find a feeding grain for the farm animals and the value of a small gram ration to the cattle during periods of hard work on the farm could not be gainsaid. Four acres were accordingly sown with gram in October 1910. The crop throve vigorously, and in early April 1911, the plants were set with a heavy crop of well filled pods. Suddenly it was found

that the entire area was affected by the gram caterpillar, "*chloridea obsoleta*" and in very few days there was hardly a pod from which the grain had not been eaten out. The crop was ruined and was promptly burned. It was then that the zamindars of a village near by remembered that the gram of the district had been cursed by a fakir who considered that he had been ungenerously treated during the harvesting of the gram crop. Further diligent enquiry in the district tended to show that the pulse could not be relied on: so oats were imported for cold season trial in 1911-12. Bihar oats, sufficient to sow four acres, were very kindly supplied from Pusa, and Messrs. Sutton, of Reading, supplied selected grain, for one acre each of their Abundance, Grey Winter and Black Tartarian varieties. The seed was sown on 5th November. Abundance ripened on 15th May, and Plate LV shows the magnificent crop of this variety being cut by the Rajah reaper. The straw almost throughout was over 6 feet in height, and stout as Sorghum vulgare when that cereal is grown for fodder. The grain weighed 43 lbs. to the bushel, and was a beautiful clear golden yellow in colour. Black Tartarian ripened 10 days later than Abundance, and was less rampant than the latter variety. The grain weighed 47 lbs. to the bushel. Grey winter ripened last: in fact, this variety was caught by a week of real hot weather which caused it to ripen too rapidly, yet the grain proved to be remarkably heavy, weighing 45 lbs. to the bushel. This variety also yielded most perfect soft bhusa, and it is undoubtedly especially suitable for curing to oat hay. Black Tartarian was not expected to weigh better than Abundance. The grain of the latter variety was plump, beautiful clear yellow in colour, and it handled well. Its straw was however, much too coarse for *bhusa*. Bihar oats, on the other hand yielded good straw and *bhusa*, but poor and bearded grain of bad colour. The weight of grain per bushel in all of the varieties is good, and better than was expected, especially as the land was not level and the crop was irrigated in places once only. It is for this reason that the outturns of grain and straw were not weighed. The oat crop is not important in India generally, but the trial

PLATE LV.

is of considerable interest in the N. W. F. Province and in the Punjab where oats do well, yet are chiefly imported from Meerut, Bihar and elsewhere at rates which not infrequently exceed the price of good wheat. In the Provinces named, constant supplies at reasonable rates would be appreciated by the commissariat of the Cavalry, Supply and Transport, and Mule Corps. It remains to be seen if the imported oats will maintain their quality in the N.-W. F. Province, and it is expected that further trials will be carried out by officers in charge of grass farms who have shown keen interest in the Agricultural Station trials.—(W. Robertson-Brown.)

Soya Bean Cake for Dairy Cows.—Extensive experiments with a large number of cows have been carried out in Denmark with regard to the effect of soya bean cake on the yield and fat content of the milk of dairy cows and on the quality of the butter. In its influence on the yield and fat content of milk the soya bean cake was found to be in no way superior to the mixture of other concentrated foods against which it was tested, *viz.*, decorticated cotton cake, earthnut cake and sunflower seed cake. As regards the quality of the butter, the soya bean cake had no effect on the aroma and flavour, but produced butter of a firmer consistency than the other cakes tried. It is concluded that soya bean cake may be added with advantage to a mixture of such concentrated foods as produce a soft butter. (*Agricultural Gazette, London, Jan. 1st, 1912.*)

Restricting or Redivision of Land into Compact Holdings.—In some countries land is subdivided among a large number of proprietors into various scattered pieces often of a very small size. The holding is not one continuous piece of land but scattered and broken up into small portions very frequently at great distances from one another. Under such conditions many economic evils result. A large area is unnecessarily taken up in boundaries, roads, and hedges which by remaining unproductive cause a

serious loss to cultivators and also to the State. Supervision on the part of the farmer becomes more difficult when he has to go from place to place and much of the time which he can ill afford to lose in busy seasons is wasted. The cost of production is also considerably increased. It also follows that under such conditions stimulus to improve upon the general cultivation mostly vanishes. Such has been the condition of holdings in Austria. In 1910, 5,809,610 proprietors owned 56,899,419 holdings, that is to say, the landed property of each was divided into about ten portions and most of the holdings were less than five hectares.* The State could not remain indifferent and intervened with legislation for the better arrangement of the rural property so as to render it more profitable. As somewhat similar conditions prevail in parts of India, a knowledge of the measures adopted in that country to bring about an amalgamation or better arrangement of rural holdings will not be without some interest to the readers of this Journal. The information in this note has therefore been extracted from the April, 1912, number of the Bulletin of the Bureau of Economic and Social Intelligence issued by the International Institute of Agriculture at Rome. The first measure taken was to encourage a fresh adjustment of lands among the various proprietors on the basis of voluntary agreement among themselves by exempting the contracts from payment of all taxes and stamp dues. There is total exemption from these charges when the portions exchanged are of equal value or when the value of one does not exceed half that of another. In the case of mortgaged land the consent of the parties interested is always necessary unless a new mortgage is registered for the detached portions of the property mortgaged and the burdens on the divided land property assume the form of simultaneous mortgage. But in case a mortgagee opposes the exchange of the land, his opposition may be declared null by competent authority, when the exchange is calculated to increase the yield of the exchanged lands and when the

* One hectare = 2½ acres nearly.

mortgage rights do not suffer. But such exchanges based upon voluntary agreement between two parties were bound to be isolated and rare, and it was found that they would not help much in eliminating the evils resulting from the existing conditions of landed property. It was necessary to promote the collective action of a certain number of landholders, if possible of those of an entire commune, to bring about the desired result.

The fundamental law, that of the 7th of June, 1883, established that when the majority of proprietors in a commune desire the redivision of land, the minority cannot resist. It is more than just that the desire of the majority should suffice, because if unanimity among the proprietors were made necessary in order to proceed with the restriping, it would be impossible to reach any practical result, the influence of tradition on the peasants being so great that they can with difficulty make up their minds to renounce their inveterate habits.

When the majority has pronounced in favour, the State intervenes to carry out the operation of restriping. It consists in the sub-division [illegible] of a given area with a view to increasing its productiveness, regardless of its previous partition. All farms included in the area shall be considered as a whole to be divided amongst the holders in such a manner that each shall receive a tract of land in single piece or two pieces according to circumstances to the value of the scattered portions before possessed by him.

The scientific distribution of a comparatively large land area, so that the rights of all may be safeguarded, is a task replete with such difficulties from the technical, economic, and juridical point of view as well as from the surveyor's, that good results could not be expected unless the State intervened, settling the plan of operations, and getting it carried out by competent and experienced officers. It is only when there is full guarantee of the most complete impartiality and absolute respect for the rights of all parties that the minority can be obliged to accept a measure to which it is opposed. For detailed information

regarding the exact procedure followed the reader is referred to the Bulletin mentioned above.

The operation of restriping is thus very complicated and costly. In Austria the expense is borne partly by the State and partly by the parties concerned. The deeds of all kinds, documents, etc., are exempt from taxation and stamp duties. Wherever restriping has been carried out, it is reported to have realised the results expected from it.—(EDITOR.)

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ARSENIC IN MILK: The Agricultural Journal of the Union of South Africa for June (1912) publishes a report of the Government Analyst, Johannesburg, on the alleged injurious effects of arsenical dipping upon milk. Tests were made to determine the presence and, if so, the quantity of arsenic in milk obtained from cattle which are dipped weekly in an arsenical bath and are habituated to it for years. In none of the samples examined was there more than 0·0045 grain of arsenious oxide present in a gallon of the milk; while in nearly half of the samples examined no arsenic was found. The official dose of arsenic is from 0·0166 to 0·066 grain; therefore at the maximum half a pint of the arsenical milk would contain only 1/60th of the minimum official dose. It will thus be seen that the quantity of arsenic, if at all present, in milk derived from dipped cows is harmless. The fact that some of the samples were free from arsenic indicates that arsenic is not absorbed by the animals and secreted in the milk; the traces of arsenic present being probably due to accidental contamination possibly during the process of milking.—(EDITOR.)

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MOLASSES OR TREACLE FOR STOCK FEEDING:—Much has been written about the feeding value of molasses or treacle for stock and its value as such has often been exaggerated. At the same time, however, it has been demonstrated that a little molasses in the feed is quite beneficial, acting both as a tonic and in the case

of cows as a stimulant to greater and richer milk production. In the United States there is perhaps no stock feeding material that has aroused so much general interest amongst stock-owners and feeders as Louisiana low grade molasses (or "Blackstrap" as it is otherwise known). The custom of feeding molasses to the working stock on the large sugar estates of Louisiana has been almost systematically adopted only within the past few years. Previously when the price was extremely low, quantities of the material were run into large iron troughs and the mules allowed free access to it, and to some extent this practice still prevails. Its true value as a food-stuff has become more apparent of late years, however; and as the question of feeding economically has become one of considerable importance, it is being used more as an ingredient of the "balanced ration" and as a rule mixed with other concentrates. The chief value of molasses as a food is its economic source of carbohydrates (sugar), some idea of which may be had from the following (taken from a bulletin issued by the Louisiana experimental station).

	Diffusion Molasses.	Mill Molasses.
Carbohydrates (Sugars	67·07	65·90

The above shows how rich this material is in the carbohydrate nutrient, and when it is known that these sugars are almost, if not completely, digestible, its value is still further enhanced. (*The Agricultural Journal of the Union of South Africa for June* 1912.)

* * *

THE FLOWERING OF THE MANGO. Mango is one of the most delicious fruits of the Tropics, and it is rightly called in India "Amrita Phala" or Nectar-fruit. As its Botanical name, *Mangifera indica*, indicates, it is a native of India. But India is not its only home. It is a fruit of the Tropics, as De Candolle remarks: "It is impossible to doubt that it is a native of the South of Asia or of the Malay Archipelago, when we see the

multitude of varieties, cultivated in these countries, and the number of ancient common names."

Although it is a native of South of Asia, yet India is the only place where its cultivation is regularly carried on from very ancient times, and it has reached a high degree of perfection. Recently its cultivation is extending beyond Asia, in Egypt and Malta. Some years ago, an old mango tree produced a fruit in Kew Gardens, England.

In its natural state, the fruit is small with fibrous flesh and acrid taste. The mango flourishes well throughout India. It requires a hot, moist climate and a well drained soil. During the Mogul period, its cultivation was much encouraged. In the Deccan, the Peshwas paid much attention to its cultivation, and some trees planted in the reign of the last Peshwa, are still to be seen near Poona. The Portuguese of Goa took mango cultivation in their hands and produced some of the best varieties. The art of grafting, it is said, was first introduced into India by them.

After the advent of the English into India, some Englishmen made a study of Indian fruits and plants. Woodrow in the Deccan, and Maries in Bengal made special study of the mango, and much of our knowledge of mango cultivation is due to their labours. Mr. Maries collected as many as five hundred varieties of mango from different parts of India; this, indeed, is a high record which has not yet been surpassed.

Each of the varieties of mango has its peculiarity in shape, colour, taste, odour, the time for ripening the fruit, etc. The season of mango flowering throughout India begins from January and ends in April generally. There are some varieties named "Bhadayas" and "Kattikas" in Malda and Tirhoot which flower in May or June, the fruit ripening in October and November.

It must be noted here that every mango tree does not flower every year. In the Deccan, where its cultivation is carried on to a great extent, it may be safely said that 50 per cent. of the total mango trees do not flower every year. The same is the case in a greater or less degree throughout the whole of India. This

irregularity has been observed, in grafted as well as ordinary trees. Instead of flowering in January or February, they simply put forth new foliage and flower in January next. This is the case with trees under good cultivation: thus showing that this irregularity is not due to the want of nourishment. On the other hand, there is a great number of trees which flower every year. Again, there are many trees which flower in September and November, instead of in January and February, while there are some which flower twice a year, in January and in September.

The writer has observed trees flowering in September to November at various places, in the Southern Mahratta country. On the Poona side, the number of such trees is quite small. One place in the Southern Mahratta country where the number of such trees is quite large may be particularly mentioned.

"Arag," a small village, in the Ichalkaranji State, is the famous place; and when it was visited in October 1911, I was quite surprised to see so many trees in blossom at that time. Those trees which flower in September or October may or may not flower in January next. Sometimes there are two flowerings in a year.

Mangoes, produced in November or December, are known as "Shalu" (rabi) mangoes. In Bengal, there are two varieties known as "Baromashia" (fruiting throughout the whole year) and "Tiphala" (fruiting thrice a year), which, as their names indicate, flower twice or thrice during a year.

In the Straits Settlements, the usual season of mango flowering is during the months of April and May. Again, there are many trees which flower in October and November; while there are a few trees, which may flower twice during a year.

From what is given above, it can be seen that there is no fixed period of mango flowering. Some trees flower every alternate year, some every year, some in January and some in September. On the basis of these flowering periods, all the mango trees may be classified under three divisions.

(1) The first division comprises all the trees, which more generally flower every alternate year.

(2) The trees which flower every year may be put in the second division.

(3) All the trees that flower in September or October and those which flower in January and again in October—such cases are few—may be put in the third division. The number of trees of the third division is comparatively small.—(K. V. TAMHANKAR.)

* * *

IMPROVED METHODS OF RICE CULTIVATION IN CHHATTISGARH.—The Department of Agriculture, Central Provinces, now recommends with confidence the following improved methods of rice cultivation in Chhattisgarh :—

(*i*) irrigation :

(*ii*) transplantation :

(*iii*) the cultivation of selected Raipur *Gurmatia* variety :

(*iv*) manuring with sann-hemp and bone-meal.

(*i*). Experiments carried out on the Raipur farm and in the villages where the outturns of irrigated and unirrigated paddy were compared prove that irrigation, if done in time, greatly benefits late and medium rice. The crop experiments carried out at demonstration centres last year showed that irrigation had accounted for an average increase of 257 seers for late and medium paddy. Two years ago the increase amounted to 292 seers : while this year the increase was 155 seers. If the price be taken at 25 seers a rupee, the money value of the increase ranges from Rs. 6 to 12 per acre. In a year of drought irrigation assures at least an average crop, while without irrigation the crop is either very poor or a complete failure. Mr. Clouston, therefore, strongly advises cultivators to irrigate all paddy land and to do so in good time. Some cultivators decide to apply for water only in the event of rainfall being short. But this is distinctly bad policy, for by omitting to irrigate early in the season the outturn is reduced to the extent of an anna or more. For example, rice-fields have sometimes to be irrigated before puddling for transplanting and the nursery beds may also require to be irrigated. If in such cases irrigation is not given in July

when it is needed, copious irrigation later on in August and September will never make up for damage done to young seedlings for want of it earlier in the season.

(*ii*). The increase due to transplantation is very considerable. The Department has each year, for the last four years, shown by demonstration in the villages that transplanted rice gives about $\frac{1}{3}$ more paddy than a *bias*i (broadcasted) crop. Crop experiments were made last season in 49 villages, and the transplanted crop gave an increase of 346 seers of paddy. The total area transplanted under the supervision of the Department in Drug and Raipur last season was about 7,000 acres. It is hoped to do a very much larger area this year. Great stress is laid on four points

(i) that the nursery beds should be manured and sown by the help of irrigation before the rains break or in the very beginning of the rains at the very latest :

(ii) that transplantation should be started when the seedlings are 4 weeks old and that they should all be transplanted before they are seven weeks old ;

(iii) that the plots should be thoroughly puddled and levelled before transplanting :

and (iv) that the seedlings should be planted about 6 inches apart.

It is hopeless to expect a good crop if transplanting is carried out after the first week of August. It is equally futile to expect a good outturn from seedlings which are transplanted when over 7 weeks old, for at that age the seedling begins to form joints and if transplanted it fails to tiller freely.

(*iii*) To get the very best results from irrigation and transplantation a heavy yielding variety of paddy should be grown. Mr. Clouston strongly recommends *Gurmatia* of which he now has a large supply of selected seed for distribution every year on the Raipur farm.

(*iv*). Rice is grown in Chhattisgarh year after year on the same land, over large areas, without any manure. But the outturn of paddy can be largely increased by manuring the

plots with cattle dung. Where there is an abundant supply of this manure, there is no need of trying any other. But the supply available is very inadequate. The Department, therefore, recommends the use of sann-hemp and bone-meal as manures for paddy where cattle dung is not available to the cultivators. Green manuring with *sann* was demonstrated in 10 villages last year and gave an average increase of 238 seers of paddy worth Rs. 9 per acre: the cost of green manuring in this way does not exceed Rs. 4 per acre. Bone-meal has also done very well as a paddy manure. It was tried in 13 villages last year and gave on an average an increase of 259 seers of paddy.—(*From the Agri. and Co-operative Gazette of the C. P., July* 1912.)

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THE EFFECT OF GRASS ON FRUIT TREES. Among the many interesting results obtained at the Woburn Experimental Fruit Farm, perhaps the most remarkable is the discovery that growing grass exerts a deleterious effect on fruit trees. This was one of the earliest observations, and was dealt with at some length in the third report in 1903, but a number of experiments have since been made, and are described in the thirteenth report recently issued.

2. The general result of grassing the ground after the trees have been planted is the arrestation of all healthy growth and the absolute stunting of the tree. The leaves become light in colour and unhealthy, the bark similarly becomes light coloured, while the fruit loses its green matter and becomes waxy yellow or brilliant red. This effect is particularly marked in the case of apple trees. If the grassing is done gradually, the trees accommodate themselves somewhat to the altering conditions, and finally make growth and yield fruit, though they never do so well as when grass is absent.

3. A number of hypotheses have been examined to account for these phenomena. The grass roots affect the aeration of the soil, the amount of carbonic acid present, the soil temperature, moisture, food supply, etc., and they may, as the United States

Bureau of Soils claims, excrete poisonous substances. The e
lier investigations showed that neither the aeration nor tempe
ture effects played any part in the matter, so far at least as t
growth is concerned: the present experiments are theref
directed to the investigation of the other factors. Several rest
proved that the harmful effects on the trees were not due to a
abstraction of moisture by the grass. The affected tr
exhibited none of the signs of suffering from drought or
recovery during wet seasons, while determinations of the wa
content of the grass and tilled soil at intervals throughout a y
revealed no differences sufficient to account for the effects. S
more conclusive evidence was obtained by growing trees in p
some with, others without, grass, and keeping all equally mo
the deleterious effect of the grass remained equally marked.

4. It is more difficult to test the effect of grass on the f
supply of the trees, because our knowledge of what constit
the food either of fruit trees or of grass is still far from comp
Pot experiments with the ordinary nutrient substances all le
negative results, and the conclusion is drawn that the effec
the food supply is not the determining factor.

5. Nor did it appear that the growth of grass caused
sufficient physical alteration in the soil to account for the res
There remains only the hypothesis that plant roots excrete
substance toxic to the tree roots, and for this the authors c
to have a fair amount of indirect and some direct evid
When perforated trays of sand containing growing grass
placed on the surface of the soil in which the trees were gro
so that the washings from the grass reached the tree roots
practically no exposure to the air, they had a deleterious
nearly, if not quite, as great as when grass was grown abov
roots of the tree in the ordinary way. The conditions o
experiment seem to have precluded any sufficient contact o
grass roots with the tree soil to allow of the abstracti
plant food, and, if the result is confirmed, it is difficult to
the conclusion that the grass roots have actually excre
toxin.

6. As already stated, the United States Bureau of Soils has long upheld the view that plants can excrete toxic substances, but it has been generally supposed, in this country at any rate, that the experiments of Daubeny and others put the hypothesis out of court. But Mr. Pickering has discovered an important property which the toxin (if it exists) must possess: it is extremely transient and disappears very rapidly from the soil. No toxic effect can be detected in soil removed from round grass roots, while even the washings from the trays above mentioned failed to have any bad effect if they were exposed for a short time to air.

7. A very interesting problem has been thus opened up, the development of which will be watched with interest.—(*Nature, dated 8th February* 1912.)

8. In the issue of *Nature*, dated 20th June 1912, Mr. Pickering, in acknowledging the note above, says, that the experiments referred to in para. 5 above are now being repeated on plants, other than fruit trees, namely, tobacco, tomatoes and barley: the plants are in every case growing in soil, but the pans contain soil in some cases and sand in others. Where they contain soil the effect of the grass growing in them has been most marked, especially on the tobacco, where the plants are not one-quarter the size of those without grass: where the pans contain sand the effect has been much less, being noticeable chiefly by the paleness of the plant leaves, rather than by the stunting of growth. This indicates that the toxic effect varies considerably with the nature of the medium in which the grass is growing and harmonises with previous observations that the effect of grass on trees varies considerably with the nature of the soil. With barley no certain effect of grass has yet been noticed, and it is quite possible that grass may not be deleterious to plants of the same order as itself. It was observed that in all cases the plants with grass above them appeared just at first to do rather better than the others. This is consistent with other observations on this subject, and also with the recognised stimulating effect of toxins in minimal doses.

AUSTRALIAN DRY FARMING.—What "dry farming" has done for the Australian Wheat-grower in recent years was well illustrated at a farmers' conference in South Australia recently by the State Minister of Agriculture, who addressed the conference. The Minister himself is an owner of wheat lands in what is called the Upper Northern area of the State. "Dry farming" means the scientific ploughing of land so as to conserve in a dry year what rain the land does receive—that is, by maintaining proper contact between surface and subsoil. The Minister said he had been keeping rainfall records for years on his farms, and last year was one of the driest, especially during the growing period, which they had had for some time. Yet on only a 3½ inch rainfall he had reaped an 8 bushel harvest. In the old years with anything less than a 10 inch rainfall, he had never reaped anything. Fancy 8 bushels on a rainfall of 3½ inches. It demonstrated beyond a shadow of a doubt that something could be done by means of cultivation to assist Nature in the less favourable years. Farmers, he said, had not tackled the question yet with anything like sufficient energy and thoroughness. The lesson is being slowly learned in other parts of the interior of Australia beyond what used to be deemed the safe rainfall belt. Scientific farming is making all the difference in these districts between barren emptiness and smiling fertility.—(*The Rhodesia Agricultural Journal, Vol. IX, No. 5, June*, 1912, *p.* 739.)

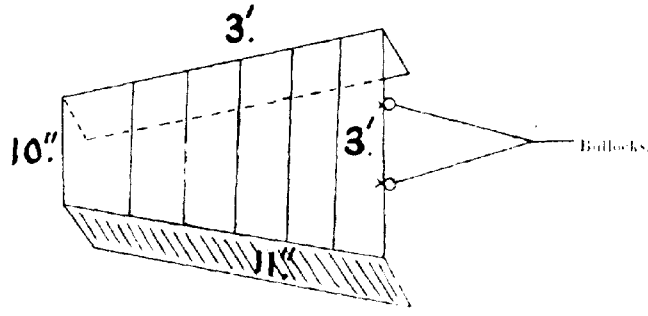
* * *

BULLOCK-DRAWN RIDGE-MAKER.—In the United Provinces about eleven millions of acres of land are irrigated every year. Before irrigation takes place the fields are divided into small plots by means of low ridges. At present these ridges are made by hand labour, the tool used being a broad-bladed wooden scraper worked by two men. To complete a ridge two journeys across the field are necessary, the same as in making potato or turnip ridges with a single furrow plough. A simple implement for doing this work cheaper and quicker has been brought to the notice of cultivators in this locality and seems likely to become

popular. It is similar to the implement used in some other countries for making low ridges for various purposes. It consists of a wooden bottomless box with the front and back knocked out.

In front it is about three feet wide and at the back ten inches. It is about eleven inches high and three feet long, and is made of strong wooden boards. It can be made in any village.

The drawing below makes the construction clear :—



The sides are sharpened to penetrate into the ground. On ground which is at all lumpy the top should not be entirely boarded in. If the last foot is left open, then clods do not interfere with the working of the implement. The sides require strengthening with iron bands. In working the implement weight is applied on the top in order to force it into the ground.

Only approximate dimensions have been given as different sizes are required to suit varying conditions. (A. E. Parr.)

REVIEWS.

DISPENSE DI ENTOMOLOGIA AGRARIA, secondo le lezioni del PROF. F. SILVESTRI, raccolte dal Dott. Guido Grandi. Parte Speciale. Portici: 1911. pp. 575, with 474 figures in the text. Price Lire 15

THIS book contains an account of the various insects which are of importance to the agriculturist in Italy from an economic point of view. They are treated of in systematic order grouped under twenty-seven orders, an arrangement which exhibits their true affinities much more clearly than the older but better-known nine order system. Each order, family, genus and species dealt with is briefly characterized and most of the species are figured. The figures for the most part attain to that standard of excellence which we have been accustomed to associate with the publications of the Portici School of Agriculture, but a few appear too diagrammatic for recognition of the species concerned; amongst such we may specify Fig. 265, 1 (*Pygaera anachoreta*, moth) and Fig. 256 (*Cavadrina cupina*), whilst the larva of the Deaths Head Moth shown in Fig. 224 wants the recurved horn characteristic of the full-grown caterpillar. These however are trivial faults and the book on the whole is an excellent guide to the economic insects of Italy, the Index providing a key to those species which attack each particular crop.

Remedial measures are not indicated as a rule, though a few notes are scattered here and there under some of the principal pests, *e.g.*, control of grasshoppers (pp. 23-29), of the vine Phylloxera (pp. 111-113), Mulberry Scale (pp. 187-192), the Angoumois Grain Moth (pp. 289-290), etc. We shall look forward to a general account of control measures from the same source.—(T. B. F.)

KUMBLIHULAS ATTACKING CROPS IN MYSORE. (*Amsacta albistriga* Wlk.) A preliminary Report. By Leslie C. Coleman, M.A., Ph.D., 12 pp., 1 Col. Plate. Dept. of Agriculture, Mysore State: Entomological Series, Bulletin No. 3. Bangalore, Government Press, 1912. Price, 8 annas.

THE term "Kumblihula" is applied in South India more or less indiscriminately to various kinds of those Hairy Caterpillars covered by the English equivalent name of "Woolly Bears." In this publication, which is stated to be merely a preliminary report dealing with practical aspects regarding this pest, the name is restricted to one particular moth, the Cumbu Hairy Caterpillar (*Amsacta albistriga*), although the popular name must not be taken to indicate that this caterpillar confines its attentions only to Cumbu. As a matter of fact, it is almost omnivorous, and this habit, as Dr. Coleman points out, adds to the difficulty of control because the caterpillars wander into the crops from the weeds on adjacent uncultivated areas. This wandering habit may, however, be taken advantage of by ploughing or digging a deep furrow or narrow ditch around each cultivated area and strewing small branches (such as of *Cassia*) in the furrow: systematic examination daily under these branches is necessary in order to kill the caterpillars which have collected there.

The main remedy recommended is the collecting by hand of the adult moths during the days following each heavy shower of rain in May and June. The white moths are conspicuous and sluggish by day, and we agree that this method of control is at once useful and practical. The use of light-traps, which was found effective in South Arcot, does not appear to have met with much success in Mysore, but it would seem worth while to make further experiments with light-traps as a supplement to hand-picking of the moths. Spraying of plants attacked by the caterpillars was tried but no success is claimed, "no caterpillars being found dead on the treated areas:" in a country like India, however, where every inch of ground is regularly quartered by hungry ants, any dead insect is soon discovered, cut up, and carried off, so that negative evidence of this nature loses a good deal of

its value. Spraying of crops over a large area is out of the question as a practical measure for adoption by the ordinary cultivator.—(T. B. F.)

Die Fauna Der Deutschen Kolonien.—Herausgegeben mit Unterstützung des Reichs-Kolonialamtes vom Zoologischen Museum in Berlin. Reihe V. Die Schädlinge der Kulturpflanze Heft 1-3, Berlin: 1911-1912.

This work, which is being issued in parts by the Berlin Zoological Museum under the auspices of the Imperial Colonial Institute of Germany, is designed to provide an account of the insect pests of all the German Colonies, primarily for the use of officials and planters who may suddenly be called upon to deal with damage and means of prevention, both of which subjects are discussed. In writing a book of this nature, one of two methods may be adopted: the species dealt with may be grouped in scientific order or they may be arranged under the principal crops or products which they attack. The first method possesses the merit of brevity, since each insect is only dealt with once and all the information regarding it is thus found in one place: but it is more difficult for the cultivator interested only in the pests of one particular crop to find the information he requires, and he has also to pay a higher price, as the whole book or series of parts must as a rule be obtained. The second method secures to the cultivator of a particular crop complete information of the pests of his crop in the least possible space and at a minimum price; a great duplication of matter, however, is thus entailed as every common polyphagous pest has to be entered under each crop which it attacks, and a vast amount of repetition of descriptions, figures and remedies is required. This second method is the one adopted in the book at present under notice.

The first part, by Dr. G. Aulmann, gives a short description of the principal groups of insects, their life-histories, the information which should be given when sending insect pests for identification and advice, methods of collecting and preserving

insects, and a short list of insecticides with formulæ for their preparation.

Part II, by Dr. G. Aulmann and Dr. W. La Baume, contains 98 pages and 62 figures, and gives a descriptive list of the insects which attack coffee. About a dozen pests occurring in India also are described and in many cases figured, the most familiar in South India being the White Borer (*Zeuzera coffeæ*) and the Green Scale (*Lecanium viride*).

Part III (86 pages and 57 figures) contains a similar description of the insects attacking the cacao plant. About half-a-dozen species occurring in India are mentioned, of which the White Borer (*Zeuzera coffeæ*) and the Red Tree Ant (*Œcophylla smaragdina*) are the most familiar; but the list will doubtless be extended considerably when the pests of cacao are better known.

To the officials and planters in the German Colonies we have no doubt that this series of publications will be most useful from the practical point of view of providing a simply-written and well-illustrated guide to the principal insect pests of special crops, and to the Entomologist who is charged with the duty of prevention of entry of pests with plant-imports such a series is invaluable. We shall look forward with pleasure to the issue of further parts.

There are two small points to which criticism may be directed. The first is in regard to pagination: each of the three parts before us is paged separately: we think that reference to the completed volume will be simplified by continuous pagination throughout. The second point is probably owing to the dual authorship and concerns the measurements of the insects described, these are given sometimes in centimetres and sometimes in millimetres in a very arbitrary and confusing manner. Indeed, the authors themselves seem to have got confused sometimes, as witness the description of *Xyleborus compactus* (Heft 2, page 63), where the size is given as "Lange fast 1·5 c.m. (!)," which seems obviously an error for 1·5 mm. Millimetres are used almost universally nowadays in entomological literature and a uniform system is clearly desirable.—(T. B. F.)

THE REPORT OF THE INDIGO RESEARCH STATION, SIRSIAH, for the year 1911-12, by Cyril Bergtheil, Director of the Indigo Research Station, Sirsiah.

THE activities of this station seem to be chiefly directed towards selecting after analysis Java plants of high yielding power and multiplying their seed with a view to distribution among planters. Further work in this direction has again shown very great variation in the field which indicates the probability of attaining considerable improvement if this line of work is followed. It is, therefore, disappointing to learn that a large number of plants of high indigo content carefully selected after analysis were this year lost through disease. The outstanding feature in the Report is the reference made to the serious loss caused to Java seed plant all over Bihar by a disease which has so far baffled identification. The Pusa Institute has taken up its investigation and the Imperial Mycologist and Entomologist are trying to find out whether it is due to a fungus or an insect pest. *Psylla* is reported as doing considerable damage to the plants, but it seems unlikely that the whole of the damage is due to it.—(EDITOR.)

BULLETIN OF THE IMPERIAL INSTITUTE.

THIS Bulletin was first published in 1903. It appears quarterly and contains: Reports on investigations conducted in the Scientific and Technical Department of the Imperial Institute; articles and notes dealing with mineral and vegetable economic products; and a quarterly summary of information on recent progress in agriculture and the development of natural resources.

Until this year, the "Bulletin" has been published by the Imperial Institute, but owing to the increased demand for it, its publication has now been undertaken by Mr. John Murray, 50a, Albemarle Street, London, W.

The principal contents of the first number of the new series are as follows:—

Rubber resources of Uganda; Some Cotton soils of the Nyasaland and Uganda Protectorates; Kola nuts from British

West Africa: Coca leaves from Ceylon and the Federated Malay States; Aromatic grass oils, Part III; Hibiscus fibres from the Northern Territories, Gold Coast; Timbers from Uganda; Sumach from Cyprus; Economic products from Mauritius; The coconut and its commercial uses, Part I; Cultivation, preparation and utilisation of hemp and hemp seed (*Cannabis sativa*); Cultivation and preparation of ginger; Agricultural work in Seychelles; Candelilla wax; Sisal hemp in Quilimane; New Zealand hemp; Iron ore from Trinidad; Copper-mercury ore from Queensland; Native labour regulations in Mozambique.

The second number has the following principal contents:—

Tobacco industry of Ceylon; Some new Gutta-yielding plants from the Gold Coast; *Ficus elastica* rubber from Southern Nigeria; "Balata" rubber (*Ficus Vogelii*) from Southern Nigeria; The rubber of *Cryptostegia grandiflora*; Silk from India; Cotton and Sisal hemp from Papua (British New Guinea); Fibres from India; Utilisation of *Cæsalpinia digyna*; Oil-seeds of *Telfairia pedata*; *Lophira* oil-seeds from West Africa; Oils and Oil-seeds from Hong-Kong; West African cocoa; The cultivation of cigar tobacco with special reference to Java; The coconut and its commercial uses, Part II; Shea nuts and Shea butter; Rubber tapping experiments in Southern Nigeria; Economic developments in the Belgian Congo; West Indian satinwood; Oil of "Nepal Camphor wood"; Citronella grass; *Mesembryanthemum Mahoni* roots from the Transvaal; Rubber Exhibition in Java; Cultivation of fibres in Java; "Root-cotton;" Perilla seed and oil.

The annual subscription to the "Bulletin" is 10*s*. 6*d*. or 11*s*. post free; single numbers may be purchased at 2*s*. 6*d*. each or 2*s*. 9*d*. post free. Subscriptions may be paid through any bookseller, or if no bookseller is available they may be sent direct to Mr. John Murray, 50a, Albemarle Street, London, W.

LIST OF AGRICULTURAL PUBLICATIONS IN INDIA FROM THE 1ST FEBRUARY TO 31ST JULY 1912.

No.	Title.	Author.	Where published.
	General Agriculture.		
1	The *Agricultural Journal of India*, Vol. VII, Parts II and III. Price per part, Rs. 2; annual subscription, Rs. 6.	Agricultural Research Institute and College, Pusa, Bihar.	Messrs. Thacker, Spink & Co., Calcutta.
2	Third Report on the Introduction of Improvements into Indian Agriculture by the work of the Agricultural Department. Price, annas 2 or 3*d*.	Board of Agriculture in India for 1911.	Government Printing, India, Calcutta.
3	Report on the Flax Experiments conducted at Dooriah during the year 1911-1912. Bulletin No. 30 of the Agricultural Research Institute, Pusa. Price, annas 1 or 2*d*.	E. M. Vandekerkhove, Flax Expert to the Bihar Planters' Association.	Ditto.
4	The Improvement of the Yield and Quality of Wheat in India in *Hindustani Type*.	A. Howard, M.A., A.R.C.S., F.L.S., Imperial Economic Botanist and Gabrielle L. C. Howard, M.A., Personal Assistant to the Imperial Economic Botanist.	Baptist Mission Press, Calcutta.
5	Summary of the methods of conducting the Agricultural Shows of Bengal, Departmental Record No. 1 of 1912. (Not for sale).	E. J. Woodhouse, M.A., Principal, Agricultural College, Sabour (Bhagalpore).	Bengal Secretariat Press, Calcutta.
6	Hand Book on Exhibitions, Departmental Record No. 2 of 1912. (Not for sale).	Ditto.	Ditto.
7	*Quarterly Journal* of the Department of Agriculture, Bengal, Vol. V, No. 3 (January 1912). Price, 6 annas.	Department of Agriculture, Bengal.	Ditto.
8	Season and Crop Report of Bihar and Orissa for the year 1911-1912.	Department of Agriculture, Bihar and Orissa.	Government Press, Bihar and Orissa, Ranchi.
9	Second Wage Census of Bengal taken in April 1911.	Ditto.	Ditto.
10	Annual Report on the Partabgarh Agricultural Station for the year ending 30th June 1911. Price, 8 annas.	Department of Land Records and Agriculture, United Provinces.	Government Press, United Provinces, Allahabad.
11	Note on Aligarh White-flowered Cotton, in Hindi and Urdu.	Ditto.	Standard Press, Allahabad.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
12	Note on American Cotton, in Hindi and Urdu.	Department of Land Records and Agriculture, United Provinces.	Standard Press, Allahabad.
13	Note on Sabaria Wheat, in Hindi and Urdu.	Ditto.	Government Press, Allahabad.
14	Note on Ridge Maker, in Hindi and Urdu.	Ditto.	Faizeam Press, Aligarh.
15	Note on Groundnut Cultivation, in Hindi and Urdu.	Ditto.	Ditto.
16	Note on *Saretha Ukh*.	Ditto.	Hewett Press, Aligarh.
17	An Examination of the Seed Supply of the Ahmednagar District. Part II, Bulletin No. 50. Price, 2 annas or 3*d*.	G. D. Mehta, L.Ag., B.A., S.D.A., N.D.D., Supernumerary Agriculturist.	Government Central Press, Bombay.
18	Muscovado Sugar Machinery and its scope for *gul* manufacture in India. Price, 8 annas or 9*d*.	G. N. Sahasrabudhe, L.A.	Ditto.
19	Agricultural calendar for 1912-13 in English, Tamil, Telugu, Malayalam and Canarese.	Department of Agriculture, Madras.	Government Press, Madras.
20	Agricultural College, Coimbatore. Leaflet No. II of 1912.	R. Cecil Wood, B.A., Principal, Agricultural College, Coimbatore.	Ditto.
21	Agricultural and Co-operative Gazette, monthly publication, February to July 1912. Price, 2 annas per copy.	Department of Agriculture, Central Provinces.	Printed at the Deshsevak Press, Nagpore.
22	Rhubarb. Bulletin No. 11. Revised Edition, in English and Khasi.	R. L. Proud lock, Actg. Agricultural Expert, Assam.	Assam Secretariat Printing Office, Shillong.
23	Asparagus. Bulletin No. 11. (Revised Edition).	Ditto.	Ditto.
24	Memorandum to accompany the return of the average yield per acre of the principal crops in Assam based on experiments made up to 1911-12.	Department of Agriculture, Assam.	Ditto.
25	What kind of Paddy to grow and how to obtain pure seed. Cultivators' leaflet No. 31.	Department of Agriculture, Burma.	Government Central Press, Rangoon.
26	Para Rubber. Cultivators' leaflet No. 36 (in Burmese).	Ditto.	Ditto.
27	*Quarterly Journal* of the Scientific Department of the Indian Tea Association. Parts I—II, 1912.	Scientific Department, Indian Tea Association.	Catholic Orphan Press, Calcutta.
28	Fodder Crops of the Punjab ...	Sir James Douie, K.C.S.I.	

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
29	Report of the Indigo Research Station, Sirsiah, for the year 1911-12.	Cyril Bergtheil, Director of the Indigo Research Station, Sirsiah.	Baptist Mission Press, Calcutta.
30	Rural Economy in the Bombay Deccan. Price, As. 6/.	G. F. Keatinge, I.C.S., Director of Agriculture, Bombay.	Longmans Green & Co., Bombay.
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